State of Oregon
Department of Environmental Quality Memorandum

Date: November 22, 2010

To: Environmental Quality Commission

From: Dick Pedersen, Director

Subject: Agenda item M, Informational and discussion item: DEQ's and Hermiston Foods' efforts to address neighbors' complaints about odors and overspray from Hermiston Foods' process wastewater land application
December 9-10, 2010, EQC meeting

Purpose of item

DEQ will update the commission on progress made towards reducing odors and overspray from Hermiston Foods' land application of process wastewater.

Why this is important

Neighbors near Hermiston Foods land application property say strong odors are negatively affecting their quality of life, threatening property values and possibly contaminating their groundwater. Since June 2010, 15 neighbors have lodged multiple complaints about odors and overspray with the company. Several neighbors addressed the commission at the August 2010 and October 2010 EQC meetings expressing their concerns and frustrations with DEQ's and the company's responses. The previous land application site, Windblown Ranch, and the new site, Chowning and Koester, are located within the Lower Umatilla Basin Groundwater Management Area, which is designated a management area based on elevated groundwater nitrate concentrations.

Background

Hermiston Foods has operated a vegetable processing plant and an industrial wastewater treatment facility south of Hermiston since 1990. Unlike other vegetable processors in the area that operate year-round to process potatoes, the Hermiston Foods plant operates seasonally to process asparagus, peas, sugar snap peas, carrots and lima beans. Wastewater is generated from vegetable processing, washing, grading, and transporting. Hermiston Foods generates approximately 100 million gallons of wastewater annually, mostly between June and November. During the balance of the year, the plant is idle with equipment maintenance, testing and refinement of the processing operation. Sanitary sewage is discharged to the Hermiston sewage treatment plant. Hermiston Foods' wastewater contains nitrogen compounds that can be beneficially reused by irrigation on agricultural crops. Between 1990 and 2009, Hermiston Foods operated a land application program on the Windblown Ranch site. The site included a plastic-lined three million

gallon surge pond, a pump station, flow meters, two 125-acre center-pivot irrigation circles, and 14.6 acres of hybrid poplar trees. Seven groundwater monitoring wells were used to monitor impacts to the shallow groundwater aquifer at the Windblown Ranch site.

On Jan. 8, 2009, Hermiston Foods notified DEQ that it intended to move its wastewater storage lagoon and land application activities from Windblown Ranch to the new site, which consisted of the Chowning and Koester Farms and totaled 511.33 acres, of which 476 acres are irrigated. Hermiston Foods proposed and DEQ approved plans to construct a 10 million gallon, polypropylene-lined wastewater pond at the new site. The plans included aeration to control odors. Twelve groundwater monitoring wells were installed at the new site to monitor impacts to the shallow groundwater aquifer.

Additional considerations

Although the size of the pond and land application areas increased with the move to the new site, Hermiston Foods has stated that the volume of wastewater will not increase and nitrogen loading should have been reduced because of the larger volume of the new site's wastewater pond. For a number of operational and crop management reasons, Hermiston Foods has not been able to land apply all of its process water as planned, leaving the company with excess storage pond water.

In October 2010, the company and its consultant, IRZ Consulting, proposed that DEQ allow Hermiston Foods to use the checkbook method of irrigation and limit hydraulic loading to the evapotranspiration rate on an annual, as opposed to monthly, basis. The permit requires a monthly basis. The company claims that DEQ's hydraulic loading restrictions force Hermiston Foods to store wastewater in the pond, causing odor complaints and stressing the crops.

In order to prevent nitrate leaching below the root zone and adverse impact to groundwater, DEQ limits hydraulic loading from all sources including precipitation and supplemental water to the crop-specific evapotranspiration rate on a monthly basis. This is important because of the already-elevated groundwater nitrate concentrations in the Lower Umatilla Basin.

In November 2010, Hermiston Foods requested permission to exceed the evapotranspiration rate on selected fields because the company projects wastewater flows until plant closure to exceed the remaining capacity in the pond. The company estimates that it will need to irrigate about 5 million gallons in November. DEQ worked with the company to find a solution for more wastewater application. In order to ensure

groundwater protection, DEQ requested analyses of remaining soil moisture storage capacity, along with projected precipitation and evapotranspiration during the upcoming winter months. DEQ determined that additional irrigation at this time would violate the permit's hydraulic loading limit that is designed to protect groundwater. In March 2010, DEQ issued the company a warning letter for exceeding its hydraulic loading permit provisions, and explained that a second such violation within a 36-month period would likely result in civil penalties. Therefore, DEQ denied the company's request for additional irrigation. The company stated that it had limited options to manage the anticipated remaining process waste water, and that it would have to shut down the facility and sell the remaining carrot harvest.

Report to EQC

At the August 2010 EQC meeting, the commissioners requested that DEQ provide a written summary of the history, permit activity, response to complaints, answers to the questions asked and a path forward.

In summary, the following activities have occurred between December 1989 and November 2010:

- One permit issuance, three permit renewals, and three permit modifications
- No complaints received between June 1996 and 2009
- 116 complaints received by Hermiston Foods from June 14, 2010, to Oct. 16, 2010, of which 78 percent were from two households
- Eight compliance inspections since permit issuance
- Six enforcement actions, including:
    - 11/8/96: Notice of noncompliance - Failure to land apply in accordance with permit conditions
    - 3/3/08: Warning letter - Nitrogen loading in excess of approved agronomic rate
    - 2/10/09: Warning letter - Nitrogen loading in excess of approved agronomic rate; failure to certify annual report
    - 11/24/09: Warning letter - Irrigating 35,000 gallons on a site not permitted for land application
    - 3/16/10: Warning letter - Hydraulic loading rate exceedance
    - 6/30/10: Warning letter - Allowing irrigation to leave permitted site (overspray on road)

A full report of the above items, including answers to questions posed by neighbors during the August EQC meeting, is provided in

attachment A.

Public involvement

DEQ invited 35 neighbors, with contact information provided by Hermiston Foods' complaint log, DEQ's complaint log and the Umatilla County Land Use hearing records, to a Sept. 28 listening session at the Hermiston Oregon State University Experimental Station. Eight neighbors attended. DEQ also invited Lisa Hanson, deputy director of Oregon Department of Agriculture, Jim Cramer, ODA Good Agricultural Practices program manager, Umatilla County Commissioner Larry Givens; Umatilla County Planning Director Tamra Mabbott and Umatilla County Code Enforcement Officer Gina Miller.

The agencies listened to concerns from the neighbors and answered their questions. Most concerns pertained to odors, nitrates in groundwater, and overspray or wind drift of wastewater. A summary of the meeting can be found in attachments A and B. Answers to questions raised during the listening session can be found attachment C.

DEQ held a second listening session Nov. 4, 2010, and invited 35 neighbors and Hermiston Foods to the session at the Hermiston OSU Experimental Station. Again, eight neighbors attended; however, not all the same neighbors attended as did for the first listening session. DEQ invited Lisa Hanson, Daniel Cain, Department of Human Services Public Health Division, Umatilla County Commissioner Larry Givens Umatilla County Planning Director Tamra Mabbott, Umatilla County. Code Enforcement Officer Gina Miller and Umatilla County. Environmental Health Supervisor Melissa Newman. Seven Hermiston Foods/NORPAC representatives and one IRZ representative attended. In general, neighbors stated concerns of odors, groundwater contamination, overspray, concerns about bacteria and mold in the irrigation water, and reduced quality of life and property values.

Summary notes of this meeting can be found in attachment A and attachment D.

Actions taken to reduce odors and overspray

To date, Hermiston Foods has taken the following actions to address odor issues and overspray:

- Replaced plant and wastewater pond screens with fine mesh
- Experimented with odor-masking agents and "liquid-live" beneficial bacteria for the pond
- Installed drop tubes on pivots
- Reduced height of some pivot nozzles to four feet
- Changed some nozzles to make larger water droplets that are

less likely to cause drift
- Reduced irrigation pressure from 55 psi to 42 psi

Next steps

Hermiston foods has committed to the following actions:

<u>To reduce wind drift and overspray</u>
- Complete an assessment of wind speed and irrigation aerosol drift distance
- Add drag tubes to the outer sections of C-1, C-3, C-5, K4A and K-5

<u>To reduce odors at the pond</u>
- Continue to develop pH, dissolved oxygen and biochemical oxygen demand data from the wastewater system
- Plant trees around the pond in spring 2011
- Continue to evaluate the need for an additional aerator in the pond
- Arrange future hay harvests to assure that irrigation can continue on some parcels and that all alfalfa fields are not taken out of production simultaneously to prevent overloading the pond

<u>To reduce odors at irrigation systems</u>
- Review complaint database to confirm the number of complaints when wind is out of the southwest
- Change irrigation scheduling for special events if neighbors call in advance
- Honor complainant's requests to not send responders to visit complainants that do not want to be visited

<u>Other</u>
- Continue to improve the accuracy of flow measurements to the spray fields

Actions DEQ will take:
- Require that a dissolved oxygen profile in the pond be repeated and daily measurements be continued with a properly calibrated meter. Dissolved oxygen is used as a measure to detect aerobic/anaerobic conditions in water. When conditions go anaerobic unpleasant odors can increase.
- Based on dissolved oxygen monitoring results, discuss with Hermiston Foods the feasibility of:
    - Additional aeration or construction of a secondary treatment facility to reduce biochemical oxygen demand
    - Modifying the outlet pipe from the pond to allow for discharge from the pond at multiple levels
- Contact Troy Downing, an expert on covering dairy ponds at the Oregon Department of Agriculture, to discuss the feasibility

of covering the pond
- Provide results of Department of Human Services literature search to neighbors
- Provide neighbors with contact information for all government representatives at the listening session
- Continue working with the company and neighbors for a result that all can live with.

Actions DHS will take:
- Literature search on bio-aerosol assays

Actions ODA will take:
- Provide technical contacts for agricultural issues

EQC involvement

DEQ will provide informational updates on the progress of this effort at the pleasure of the commission.

Attachments

A. Report to EQC: Hermiston Foods
B. Meeting notes: Sept. 28, 2010, listening session
C. Questions and answers: Sept. 28, 2010, listening session
D. Meeting notes: Nov. 4, 2010, listening session

Report prepared by: Linda Hayes-Gorman
Phone: (541) 633-2018

HERMISTON FOODS

Submitted to: **Linda Hayes-Gorman**
Eastern Region Administrator

By: **Duane A. Smith**
Carl Nadler

November 10, 2010

State of Oregon
Department of
Environmental
Quality

FACILITY DESCRIPTION and HISTORY

Since 1990, Hermiston Foods has operated a vegetable processing plant and an industrial wastewater treatment facility south of Hermiston. Unlike other vegetable processors in the area that operate year-round to process potatoes, the Hermiston Foods plant operates seasonally to process asparagus, peas, sugar snap peas, carrots and lima beans. Wastewater is generated from vegetable processing, washing, grading, and transporting. Boiler blow-down, condenser water and storm water are also discharged to the treatment facility. Hermiston Foods generates approximately 100 million gallons (MG) of wastewater annually, mostly between June and November. During the balance of the year, the plant is idle with equipment maintenance, testing and refinement of the processing operation. Sanitary sewage is discharged to the Hermiston sewage treatment plant.

Principal components of Hermiston Foods' wastewater treatment system include side hill screens, sediment basins, concrete lined gutter flush system, collection sump and pump station, an underground pipeline, and land application system which includes a storage pond.

Process-related residual solids, or waste solids, consist of asparagus greens, pea pods, reject peas, carrot greenery, carrot reject scraps, rock, silt and tare dirt. Vegetable waste solids, including vegetable solids from the screens, are utilized offsite as livestock feed. Rock, silt, and tare dirt are returned on a pro rata basis to the individual growers who supply raw carrots to the plant.

Hermiston Foods' wastewater contains nitrogen compounds that can be beneficially reused by irrigation on agricultural crops. Between 1990 and 2009, Hermiston Foods operated a land application program on the Windblown Ranch. The site included an HDPE-lined three (3) million gallon (MG) surge pond, a pump station, flow meters, two 125-acre center-pivot irrigation circles, and 14.6 acres of hybrid poplar trees. Seven groundwater monitoring wells were used to detect impacts to the shallow groundwater aquifer at the Windblown Ranch site.

On January 8, 2009, Hermiston Foods notified the Department that it intended to move its wastewater storage lagoon and land application activities from Windblown Ranch to the New Site, which consisted of the Chowning and Koester Farms and totaled 511.33 acres (476 acres irrigated). Hermiston Foods proposed and the Department approved plans to construct a 10 MG, polypropylene-lined wastewater pond at the New Site. The plans included aeration to control odors. Twelve groundwater monitoring wells were installed at the New Site to detect impacts to the shallow groundwater aquifer.

Although the size of the pond and land application areas increased with the move to the New Site, Hermiston Foods has stated that the volume of wastewater will not increase. Hence, it should be easier for the company to comply with nitrogen loading limits at the New Site. This is significant because both Windblown Ranch and the New Site are located within the Lower Umatilla Basin Groundwater Management Area (LUBGWMA), which was designated as such based on elevated groundwater nitrate concentrations over a widespread area.

PERMIT HISTORY

Effective Date	Action
December 22, 1989	Permit issuance. The permit prohibited discharge to surface waters and required the permittee to land apply wastewater in accordance with a Department-approved wastewater management plan. In addition, the permit limited objectionable odors, flies, mosquito breeding, other nuisance conditions and leaching of nitrogenous compounds. Groundwater contamination was prohibited. Wastewater facility and groundwater monitoring was required in accordance with the approved plans. Expiration date: December 31, 1994.
June 18, 1996	Permit renewal. The permit prohibited nitrogen loading in excess of the maximum agronomic rates established by Oregon State University fertilizer guides and it prohibited leaching below the root zone. Provisions for storm water disposal in dry wells, or underground injection controls (UICs), were included in the permit. Specific groundwater monitoring requirements were included in the permit; however, wastewater facility monitoring was required to be in accordance with the approved Operations, Monitoring and Management (OM&M) Plan. The permit required submittal of revised OM&M and Groundwater Monitoring Plans, along with submittal of a Water Quality Analysis Report with proposed groundwater concentration limits. Expiration date: May 31, 2001
September 5, 1996 and September 17, 1996	Permit modifications. The Department modified the permit on two occasions to extend compliance dates for submittal of revised OM&M and Groundwater Monitoring Plans.
February 14, 1997	Permit modification. The Department modified the permit to extend the compliance date for submittal of a Water Quality Analysis Report with proposed groundwater concentration limits for the Windblown Ranch site.
April 1, 2004	Permit renewal. The permit established groundwater concentration limits for Total Dissolved Solids (TDS), Nitrate-Nitrogen (NO_3-N) and Chloride (Cl^-) in monitoring well MW-4. Specific facility monitoring requirements were included in the permit and the list of required groundwater monitoring parameters was increased. An additional groundwater monitoring well was required to be installed and a Water Quality Analysis Report with proposed groundwater concentration limits was required for the new monitoring well. Expiration date: March 31, 2009

August 25, 2009 — Permit renewal. Hydraulic loading was limited to the crop-specific evapotranspiration (ET) rate. Odor monitoring, control and complaint response procedures were required to be included in the OM&M Plan. The permit required closure of the wastewater pond at Windblown Ranch. Accumulated sediments were required to be removed and a characterization of the soil beneath the liner was required.

Expiration date: December 31, 2015

March 5, 2010 — Permit modification. The permit was modified to allow land application of wastewater at the New Site. Comments that were made during Umatilla County's public hearings on land use and received during the last permit renewal were addressed in the modification.

- Ponding that lasts up to 24 hours after irrigation has stopped was allowed only if adverse or nuisance conditions do not occur as a result.
- Irrigation spray, including wind drift, was prohibited beyond lands described in the County-approved LUCS.
- Irrigation spray was prohibited on roads, irrigation ditches, and well heads that are not protected by well houses.
- Irrigation spray was prohibited within 400 feet of all downgradient domestic wells, unless otherwise approved in writing by the Department.
- Groundwater monitoring and the establishment of groundwater concentration limits were required.
- Hermiston Foods' tenant's well was required to be monitored on a quarterly basis for NO_3-N for two years.
- Prior to irrigating, wells located in sprayfields were required to be abandoned or have well houses constructed over them.
- Prior to irrigating, all underground piping was required to be leak tested.
- Prior to irrigating, drop tubes with low pressure nozzles were required to be installed on all pivot irrigation equipment.
- Prior to irrigating, a swing arm on Field K-3 was required to be removed. The Department had observed ponded water in wheel ruts on that field. During the land use hearings, Hermiston Foods stated that the nozzles on the swing arm malfunctioned and did not shut off near Canal Road causing ponding. The company promised to remove the swing arm from the pivot and the condition was included in the permit modification.
- Prior to irrigating, a ponding problem in Field C-5 was required to be remedied.
- Prior to irrigating, eight new monitoring wells were required to be installed around the perimeter of the New Site bringing the total number of wells to twelve.

COMPLIANCE HISTORY

Complaints
Between June 1996 and June 2009, the Department did not receive any complaints regarding the facility.

Inspections
The Department conducted compliance inspections of the facility on August 19, 1997, October 12, 1998, June 6, 2001, June 28, 2002 and January 8, 2009. No violations were documented during the inspections.

On June 23, 2010, the Department inspected the new facility and documented two violations: Irrigation spray on the east boundary road and an end gun on Field K-3 pivot. Both violations were addressed in a June 30, 2010 Warning Letter (see Enforcement Actions, below).

On July 12, 2010, the Department inspected the facility. No wind drift was observed leaving the property and the pivots appeared to have been modified to observe the 100-foot setback.

On August 27, 2010, the Department inspected the facility during seven mph winds and observed irrigation spray blowing across a field, however it did not leave the property. An unpleasant wastewater smell was also noted at the irrigation field.

Enforcement Actions
On November 8, 1996, the Department issued a Notice of Noncompliance to Hermiston Foods for failure to land-apply wastewater in accordance with permit requirements. The company had reported a weekend overflow of the surge pond and a release of approximately 36, 000 gallons to an uncropped area. There was no discharge to waters of the State. The violation was a Class II violation of the Department's enforcement rules. To ensure that the violation did not recur, Hermiston Foods was required to perform visual inspections of the surge pond every Saturday morning.

On March 3, 2008, the Department issued a Warning Letter to Hermiston Foods for nitrogen loading in excess of the approved agronomic rate. It was a Class II violation of the Department's Enforcement Rules. Hermiston Foods was required to ensure that wastewater was managed in accordance with permit requirements.

On February 10, 2009, the Department issued a Warning Letter to Hermiston Foods for nitrogen loading rate exceedances and for failing to certify its annual report. Nitrogen loading rate exceedances within groundwater management areas are Class I violations. Failure to certify the report is a Class II violation. To correct the nitrogen loading rate violation, the company was prohibited from land applying wastewater on the hybrid poplars, which were no longer viable (see more information on page 14, and was required to ensure that nitrogen from all sources did not exceed the agronomic rates for the receiving crops. To correct the certification violation, the company was required to re-submit the annual report with a certification. In addition, as a result of the Class I violation, Hermiston Foods was issued a Notice of Permit Violation (NPV) and required to certify that the company was operating in compliance with its permit or to submit a proposal to bring the facility into compliance with the permit. On March 16, 2009, the Department received Hermiston Foods certification that it was operating in compliance with its permit.

On November 24, 2009, the Department issued a Warning Letter to Hermiston Foods for irrigating approximately 35,000 gallons of wastewater on a site that was not permitted to receive wastewater. The violation occurred following a break in the wastewater pipeline. In order to repair the break, the company drained the pipeline back to the plant and land applied the wastewater on an undeveloped field south of the plant. The violation was a Class II violation. Hermiston Foods was required to ensure that all wastewater management and disposal activities were in accordance with the permit and approved OM&M Plan.

On March 16, 2010 after reviewing Hermiston Foods 2009 Annual Report, the Department issued a Warning Letter to the company for a hydraulic loading rate exceedance at the Windblown Ranch site. Exceedance of a hydraulic loading limitation is a Class II violation. The company was required to ensure that wastewater management and disposal activities are in accordance with the permit and approved OM&M Plan.

On June 30, 2010, the Department issued a Warning Letter to Hermiston Foods for allowing irrigation spray on the east boundary road. The violation was a Class II violation. As a result, Hermiston Foods was required to observe a 100-foot setback from all access roads, public roadways and the irrigation ditch located on the northwest edge of field K-1. And, irrigation of process wastewater was prohibited at wind speeds that cause wind drift beyond property boundaries. In addition, Hermiston Foods was required to prepare and submit detailed procedures designed to prevent irrigation spray, including wind drift, from impacting roads, irrigation ditches and adjacent properties. Plans and procedures were required to include provisions for preventing variable wind speed and direction from causing wind drift in violation of the permit. Lastly, Hermiston Foods was required to remove all impact-type end guns from all pivots. The setbacks and irrigation prohibition were required until such time the Department approved procedures developed by Hermiston Foods to prevent violation of the permit. On August 5, 2010, the Department conditionally approved Hermiston Foods' proposal to install drag tubes on the outer 100 feet of pivot equipment affected by the setback. The approval letter provided that upon installation, the set-backs would be deemed removed and irrigation in the setback would be permitted.

Chronology of Recent Events and Activities

January 8, 2009. Carl Nadler and Rick Hill met with Mark Steele, Craig Williams, Roy Stephens and Bill Burich at the Hermiston Foods processing plant to discuss site authorization of the new Chowning and Koester land application sites. The contract at the old site (Windblown Farms) was to expire at the end of 2009.

January 15, 2009. DEQ received Hermiston Foods' application for renewal of its WPCF Permit.

February 10, 2009. DEQ issued a Warning Letter to Hermiston Foods for nitrogen loading rate exceedances and for failing to certify its annual report. The facility is located within the Lower Umatilla Basin Groundwater Management Area and nitrogen loading rate exceedances within groundwater management areas are Class I violations. As a result, Hermiston Foods was issued a Notice of Permit Violation and required to certify that the company was operating in compliance with its permit or to submit a proposal to bring the facility into compliance with the permit. On March 16, 2009, the Department received Hermiston Foods certification that it was operating in compliance with its permit.

May 6, 2009. DEQ issued a Discussion Draft of WPCF renewal permit to Hermiston Foods.

June 2, 2009. Carl Nadler and Duane Smith (both from DEQ) met with Mark Steele, Craig Williams, Roy Stephens and Bill Burich (all from Hermiston Foods) in DEQ's The Dalles Office to discuss the draft renewal permit.

July 2, 2009. DEQ issued a Public Notice Request for Comments on Hermiston Foods' draft WPCF renewal permit.

July 13, 2009. Ken Brown, a neighbor, called DEQ regarding concern that Hermiston Foods' proposed new land application sites would affect the water quality in his wells. Carl Nadler advised Craig Williams to locate all domestic wells by going door-to-door.

August 3, 2009. The comment period closed on Hermiston Foods' draft WPCF renewal permit for the Windblown site. DEQ received comments from eighteen (18) individuals. However during that time, Umatilla County Planning Department also invited public comment regarding land use to allow land application of wastewater at the Koester and Chowning sites. As a result of the two comment periods over-lapping, many of the comments received by DEQ pertained to the land use decision (e.g. whether land application of industrial wastewater should be allowed near residences, the effect that will have on property values and whether alternatives were considered). DEQ explained that comments pertaining to the land use decision must be directed to Umatilla County Planning; and that if the land use decision is approved, the draft WPCF permit will have to be modified to incorporate the Chowning and Koester sites. DEQ explained that at that time, public comments would be accepted on those sites. The most common comments received pertained to concerns about odors or air pollution from the wastewater system (pond and spray fields) and potential groundwater contamination from nitrates. Other comments were repeated less frequently. To facilitate Department responses, similar comments (e.g. odor or groundwater contamination) were combined into single generic comments and responses were drafted.

August 25, 2009. DEQ issued Hermiston Foods' WPCF permit renewal for the Windblown Ranch.

September 3, 2009. DEQ approved Hermiston Foods' proposal to remove accumulated sediments from the old pond and land apply a slurry of approximately two (2) million gallons on 70 acres of fallow ground at the old site. DEQ warned Hermiston Foods that it had recently received odor complaints and that if odors become an issue during the pond sediment removal operation Hermiston Foods was expected to respond appropriately to them.

September 24, 2009. Umatilla County Planning Commission – Land Use Hearing. Commission took public comments and conditionally approved Hermiston Foods land use request to apply wastewater on the Chowning and Koester sites.

November 3, 2009. Umatilla County Commission – Land Use Appeal Hearing. County Commissioners upheld the Planning Commission's decision, but removed some of the conditions the Planning Commission had imposed. The Commissioners then requested Planning Staff to prepare a letter to DEQ recommending that DEQ consider and address public comments that could not be addressed by the County. Most of the comments pertained to odor and groundwater nitrate concerns. There were also concerns about set backs or buffers. Mark Steele stated that Hermiston Foods was going to install drop tubes to control wind drift.

November 24, 2009. DEQ issued a Warning Letter to Hermiston Foods for a plan violation. The company's wastewater pipeline broke between the plant and the old (Windblown) site. The company drained the pipe back to the plant and land applied the wastewater on a field south of the plant that was not approved for land application. The violation was a Class II violation. The company plans to obtain land use approval and DEQ site authorization/permitting as a precautionary measure for future emergency use.

November 24, 2009. DEQ issued a site authorization letter to Hermiston Foods for the Chowning and Koester sites. The authorization required all wastewater storage and land application activities to be conducted in accordance with the WPCF permit and Department-approved plans. It prohibited irrigation spray, including wind drift, beyond the lands described in the Land Use Compatibility Statement. It prohibited irrigation spray on roads, irrigation ditches, and well heads that are not protected with well houses. It prohibited irrigation spray within 400 feet of all downgradient domestic wells, unless otherwise approved in writing by the Department. And it required that odor monitoring, control and complaint response procedures shall be included in the Department-approved plan and implemented by Hermiston Foods.

November 24, 2009. DEQ modified Hermiston Foods' WPCF permit to cover the Chowning and Koester land application sites and issued a Discussion Draft of the permit modification to Hermiston Foods. The permit modification required Hermiston Foods to drill four replacement groundwater monitoring wells (original wells were screened too deep), two new groundwater monitoring wells between the spray fields and neighboring wells, and two new groundwater monitoring wells on the eastern downgradient side of the Koester site.

December 7, 2009. Carl Nadler and Duane Smith met with Mark Steele, Craig Williams, Roy Stephens, Bill Burich and Steve Mueller in DEQ's Pendleton Office to discuss the draft permit modification.

December, 23, 2009. DEQ issued the formal applicant review draft of the permit modification to Hermiston Foods.

December 24, 2009. DEQ issued a Special Permit to Hermiston Foods to temporarily operate the new pond until the permit modification is issued. The permit was necessary because the company needed the new pond for storage while in the process of abandoning the old pond.

January 14, 2010. Don Walchli told Carl Nadler that he has a domestic well for a migrant camp approximately 200 yards downgradient of field K-3. He said he would get the GPS coordinates to DEQ. Carl Nadler informed Hermiston Foods of the well. Mr. Walchli did not get the GPS coordinates to DEQ.

March 3, 2010. DEQ approved Hermiston Foods' February 2010 Monitoring Well Location and Construction Plan.

March 5, 2010. DEQ issued a modification of Hermiston Foods' WPCF permit to cover wastewater land application at the Chowning and Koester sites. During the comment period, the Department received written comments from fifteen people. In general, many comments pertained to odors and groundwater contamination and the impacts odors and groundwater contamination may have on quality of life. Additional comments pertained to facility and groundwater monitoring, loss of property value, records retention, new pond design and piping, permit violations, over-spray and wind drift, ponding, and crops. To facilitate the Department's responses to comments, similar comments were paraphrased and combined. All comments that were received during the comment period were responded to.

March 16, 2010. Based on review of Hermiston Foods' 2009 Annual Report, DEQ issued a Warning Letter to the company for hydraulic loading limit exceedances at the old site. The violation was a Class II violation.

March 18, 2010. DEQ issued a Permit Action letter to remove Field S-1 from the wastewater land application program. Hermiston Foods proposed to remove the field after the permit modification established a 400-foot setback from all domestic wells.

Early June 2010. Hermiston Foods began processing peas and sugar snaps.

June 14, 2010. DEQ received an odors complaint from Don and Karie Walchli.

June 14 to August 2, 2010. Hermiston Foods received 44 odor complaints.

June 23, 2010. DEQ inspected Hermiston Foods' new wastewater pond and irrigation fields. Although the permit required installation of drop tubes with low pressure nozzles on all pivot irrigation equipment by April 30, 2010, an end gun was observed on the pivot in Field K-3. We met Craig Williams and Roy Stephens at the new wastewater pond. The aerator was running at the time of the inspection. A pea odor was evident in the area around the pond and sump. Duane Smith explained that Hermiston Foods would receive a Warning Letter for irrigation spray on the east boundary road. He also noted that the permit required drop tubes on all pivot irrigation equipment. We asked about potential overspray from the pivot on Field K-1 into the irrigation ditch and Craig said the irrigator shortened the stop. We then drove to the area between Fields C-3 and C-5. The wind was from the east and we could occasionally smell odor from the pond.

June 30, 2010. DEQ issued a Warning Letter to Hermiston Foods for wind drift of wastewater irrigation spray on an adjacent access road. The violation was a Class II violation. The Warning Letter required the company to submit detailed procedures designed to prevent irrigation spray from impacting roads, irrigation ditches and adjacent properties. Until the Department approves the procedures, the Warning Letter also established 100-foot setbacks from all access roads, public roadways and the irrigation ditch located on the northwest edge of Field K-1. And it prohibited irrigation of process wastewater at wind speeds that cause wind drift beyond property boundaries and required removal of end guns from all pivots.

July 6, 2010. In response to the Warning Letter, Hermiston Foods proposed to install drag tubes on the last 100 feet of each pivot on Fields K-2, K-3 and K-5 and then modify all other pivots in the same manner if the tubes mitigate wind drift. The company also proposed to remove all impact-type end guns except a single low mount impact-type end gun, which will be turned off an acceptable distance from the east and west boundaries on Field K-3.

July 12, 2010. DEQ inspected Hermiston Foods' land application fields. The wind was strong out of the west at the time and the company was only using two small pivots on the western edge of their fields. No wind drift was leaving their property. The pivots appeared to have been modified to observe the 100-foot setback.

July 14, 2010. Telephone Conference to discuss complaints and odor issues. Participants: Duane Smith, Carl Nadler, Hermiston Foods-Bill Burich, Mark Steele, Craig Williams, Roy Stephens.

July 15, 2010. Email to all participants summarizing telephone conference of July 14. Including outline of suggested elements for a written report from Hermiston Foods.

July 15, 2010. DEQ approved installation and operation of drag tubes on Field K-3 and agreed to allow drag tubes on other fields and lift the set back restriction and irrigation prohibition if Hermiston Foods can show that the drag tubes are successful at eliminating overspray and wind drift over a range of wind speeds and directions. DEQ did not approve end guns on any pivot. During the County land use hearings, neighbors raised concerns regarding over-spray and wind drift of irrigated wastewater and Hermiston Foods promised to mitigate their concerns with drop tubes. However since then, we have found that drop tubes are not entirely effective and Hermiston Foods has consequently proposed to install drag tubes to further mitigate the problem. Therefore, DEQ believes that installation and operation of end guns is not approvable.

July 27, 2010. Email from Duane Smith to Bill Burich requesting confirmation of preparation of a written report as described in Carl Nadler's email of July 15.

July 28, 2010. Bill Burich proposed to submit three reports over the next three weeks. The first report would address overspray and odor action plans. The second report would cover analyses of odor complaints, aeration equipment and the complaint process. And the third report would be analyses of the land application hydraulic budget/water balance and general analyses of the facility compliance.

August 2, 2010. DEQ received Hermiston Foods' first report regarding overspray and odor action plans. The company promised to lower drop tubes further, and evaluate changing nozzles and adjusting pressures within the next 30 to 60 days to further control wind drift and overspray. For odors at the pond, Hermiston Foods promised to add chemicals, install tighter screens, develop and analyze pH, dissolved oxygen and BOD data, and evaluate planting trees and adding additional aeration. For odors in the spray fields, the company promised to install drag tubes, lower drop tubes and increase droplet size.

August 5, 2010. DEQ conditionally approved Hermiston Foods' OM&M Plan and written request to install drag tubes on the outer 100 feet of other pivot equipment affected by the WL-imposed setback. The approval letter provided that upon installation, the set-backs would be deemed removed and irrigation in the setback would be permitted. DEQ also noted that odor monitoring responsibilities had been removed from a table in the OM&M Plan and that the plan appeared to be silent on the issue of odor monitoring, despite the fact that the permit required odor monitoring procedures to be included in the plan. Hence, DEQ required Hermiston Foods to propose odor monitoring procedures for DEQ approval not later than August 31, 2010.

August 5, 2010. Neila Wallace reported odor and overspray onto the road by her house during her walk at 8:00 am. Hermiston Foods responded at 9:45, within 15 minutes of receiving the complaint. However, the road was dry. The company noted that although the sprinklers on the pivot end were set to shutoff as it reached its northern and western directions, the irrigator found a bent switch which might have caused it to not function properly that morning. The irrigator fixed the switch. Hermiston Foods also noted that installation of drag tubes on the last 100 feet of pivot would limit wind drift/overspray.

August 5, 2010. DEQ received Hermiston Foods' second report regarding analyses of odor complaints, aeration equipment and the complaint process. The report showed that Hermiston Foods received 44 odor complaints from seven different neighbors between June 14 and August 2, 2010. Thirty-seven complaints came from two neighbors (Walchli (14) and Wallace (23)). The remaining seven complaints came from five other sources with none of those having more than two complaints. Of the seven different neighbors, four are located within ¼ mile of the northern boundary of the spray fields. Thirty-six percent of the complaints were between 6:00 pm and 8:59 pm; 57% were between 6:00 pm and midnight. Fifty-nine percent of the complaints occurred when wind speeds were low, one to four miles per hour. Regarding aeration equipment, Hermiston Foods concluded that more DO data are needed to provide definitive analyses. Regarding the complaint process, the company is making three changes: (1) When possible, the Hermiston Foods personnel responding to the complaints will attempt to personally contact with the complainant; (2) When possible, information will be logged showing the irrigation systems operating at the time when the complaints are received; and (3) Wind sock directions at the holding pond and Canal Road locations will be recorded at the time of the odor complaint response.

August 9, 2010. Neila Wallace sent an email to DEQ with a copy to Umatilla County Commissioner Larry Givens. She indicated that the odors were causing stress and that Hermiston Foods representatives had told her that it's not their wastewater, rather it's the irrigation ditch, a wheat field and her own lawn that she smells. Carl Nadler called Mrs. Wallace and explained some of the things Hermiston Foods is doing to control odors and overspray/wind drift. He encouraged her to ask the company to accompany her to the pond, so she could compare the odor there with the odor at her house and see the odor controls (screens, aeration,

feeding sump) they have in place. He then contacted Hermiston Foods and told them to expect the request.

August 16, 2010. DEQ received Hermiston Foods' third report regarding analyses of the land application hydraulic budget/water balance and general analyses of the facility compliance. The report showed 0.3 inch over-irrigation on one field and 0.01 inch and 0.02 inch on two other fields in May. Another field was over-irrigated 0.28 inches in July. The company noted that although four fields were over-irrigated, the soil moisture monitoring shows that only the top foot of soil ever reached field capacity. All other fields were deficit irrigated.

August 23, 2010. DEQ received Hermiston Foods' report regarding pH in the company's wastewater and the effectiveness of its pond aeration. Hermiston Foods concluded that dissolved oxygen (D.O.) profiles have shown good mixing and adequate D.O. levels at the most remote corners. However, the company admits a problem with the D.O. meter and the Department will require the study to be re-done with accurate equipment.

September 1, 2010. DEQ received Hermiston Foods' report on nozzle pressure. At lower nozzle pressures, droplet sizes are larger and there is less risk of irrigation spray blowing off of the site. On the other hand, according to the report, irrigation uniformity is compromised if system pressure drops below 40 psi. Therefore, Hermiston Foods informed DEQ that pump pressure is set at 42 psi and the pressure at the nozzles is about 40 psi. DEQ is still working with Hermiston Foods to determine if pressure reducers at each nozzle will be effective. The company also reported that it moved one pivot 100 feet away from an irrigation ditch and installed new, finer screens to remove more carrot peel at the processing plant.

September 3, 2010. Hermiston Foods agreed to cease irrigation when wind speeds exceed 15 mph.

September 22, 2010. DEQ responded in writing to Hermiston Foods reports regarding odors, over spray and the complaint system. DEQ posed 21 follow-up questions and requested a response by October 8, 2010.

September 28, 2010. DEQ met with neighbors at the OSU Experiment Station in Hermiston to hear their complaints regarding Hermiston Foods. Invitations were made to 35 neighbors, however only eight neighbors attended. Also present were Umatilla County Commissioner Larry Givens, Umatilla County Planning Director Tamra Mabbott, Umatilla County Code Enforcement Officer Gina Miller, Oregon Dept. of Agriculture (ODA) Deputy Director Lisa Hanson, and ODA Good Agricultural Practices (GAP) Program Manager Jim Cramer. In general, most complaints pertained to odors, nitrates in groundwater and overspray/wind drift of wastewater.

Neighbors stated that odors made it hard to breath, caused sore throats, is worse in mornings and evenings and affects their social lives and families. They said that Hermiston Foods' responders are slow to respond to complaints, are offensive, deny that there are odors, blame other things such as the complainant's yard, wet hay and the irrigation ditch for the odors and stand too close to them when they converse. One neighbor said she does not want the responders to knock on her door when they respond. Neighbors said that the wastewater irrigation fields smell bad even

after the irrigation has been turned off. They said the pond aerator does not run continuously and the company does not blend sufficient fresh water with the wastewater to control odors. One person suggested that Hermiston Foods cover the wastewater pond. Another said that it was impossible for Hermiston Foods to blend water without discharging fresh water to the pond.

Regarding nitrates in groundwater, one neighbor is buying bottled water because they have measured nitrates in their well water. Neighbors did not understand why there was so much variability in groundwater nitrate concentrations over the area. Commissioner Givens encouraged the neighbors to review the construction of their wells and to check their well logs to determine whether their wells were shallow or basalt wells.

Regarding overspray/wind drift, there was concern about what is in Hermiston Foods wastewater and whether it could damage crops on adjacent fields. Don Walchli, a neighbor, raises produce in the GAP program. Jim Cramer, from ODA, explained that the US Dept. of Agriculture (USDA) created the GAP program for growers that wanted to produce certified high quality crops. The program is voluntary and ODA audits crops in the GAP program in Oregon. In order to meet certification criteria, participating growers must have real-time evidence of everything that goes on the crops. That means that Mr. Walchli must have real-time evidence that chemical and bacterial concentrations in Hermiston Foods wastewater meet the certification criteria if the wastewater is over-sprayed on Mr. Walchli's crops. Absent that information, Mr. Walchli's crops would not meet GAP program requirements. Mr. Walchli is concerned about bacteria and pesticide in Hermiston Foods wastewater. He said Hermiston Foods should be able to show the neighbors what is in the wastewater, such as pesticides and cleaning products. There was concern that DEQ is not enforcing on overspray/wind drift and that the 15 mph wind speed shut-off was not conservative enough. In addition, the level of trust is down because of the recent history.

Planning Director Mabbott suggested that the County, State and Hermiston Foods work together on a creative solution such as a land trade to enable land application of wastewater elsewhere far away or grant support for construction of wastewater treatment facilities so the wastewater does not stink. In addition, Planning Director Mabbott suggested a third party check of crop-specific ET rates.

September 29, 2010. Linda Hayes-Gorman and Carl Nadler met Neila Wallace at her home at 7:30 am to "smell what she smells in the morning." On arrival there was a noticeable odor outside and inside Mrs. Wallace home. After about 20 minutes a breeze picked-up outside and the outside odor decreased. However, the odor inside Mrs. Wallace's home remained.

September 29, 2010. Linda Hayes-Gorman and Carl Nadler met with Hermiston Foods staff (Bill Burich, Craig Williams, Mark Steele, Cyd Bothum and Steve Mueller) and toured the wastewater facility. According to Hermiston Foods, the pond aerator operates 24/7. In addition, the company showed that, based on complaint records, complaint response time is less than 30 minutes, typically 7 to 10 minutes.

During the tour, drag tubes on Field K-2 were turned off, although the spray nozzles were on. When the drag tubes were turned on, some did not work. Further investigation revealed that the orifices were plugged with carrot pieces. After removing the carrots, the water that came out had a strong offensive odor. Hermiston Foods explained that carrots got through the system due to a

failure in the solids elevator conveyor at the plant. DEQ advised the company that it expected the company to maintain its equipment in order to comply with its permit.

In order to minimize odors, DEQ discussed the possibility of flushing the irrigation lines with fresh water prior to each shut down cycle. Hermiston Foods pointed out that it could lead to greater inaccuracy in hydraulic and nutrient calculations. DEQ will continue to explore this possibility with Hermiston Foods.

At the time of the visit, Hermiston Foods was irrigating with 100% effluent. The company explained that if it blended fresh water with wastewater to irrigate, then more wastewater would need to be stored in the pond. The company also explained the blending equipment and it was clear that fresh water can be blended without mixing in the pond.

Regarding crop-specific ET rates, Hermiston Foods stated that the rates provided by AgriMet did not fit their wheat and corn crops because Hermiston Foods planted their crops after the assumed crop start date that AgriMet uses. DEQ will continue discussions with the company regarding appropriate crop specific ET rates.

October 3, 2010. Neila Wallace reported that wind speeds were between 16 and 22 mph yet Hermiston Foods continued to irrigate. She said that she did not observe any overspray off of Hermiston Foods property. DEQ contacted Roy Stephens, who said that it was his understanding that the 15 mph shut-off was only for the duration of a wind storm in early September and that it was not extended.

October 4, 2010. DEQ requested Hermiston Foods to agree to extend the 15 mph shut-off agreement.

October 6, 2010. Hermiston Foods declined DEQ's request to extend the 15 mph shut-off agreement. Instead, the company promised to turn off any individual pivot or system that would risk overspray. They said they did not want to be in a situation of shutting off all systems and diverting the entire wastewater flow to the pond (where odors could develop), when wastewater could be irrigated safely without overspray issues. The company promised to complete an assessment of wind speed and irrigation aerosol drift distance.

October 8, 2010. DEQ received a letter from IRZ Consulting (Hermiston Foods' consultant) opining that DEQ's hydraulic loading restrictions forced Hermiston Foods to store wastewater in the pond, causing odor complaints and stressing the crops. In order to prevent nitrate leaching below the root zone and adverse impact to groundwater, DEQ limits hydraulic loading from all sources (including precipitation and supplemental water) to the crop-specific evapotranspiration (ET) rate on a monthly basis.

In the letter, IRZ explained that, on a daily basis, the total month-to-date net irrigation amount is subtracted from the total month-to-date hydraulic loading (ET) rate to determine the amount of irrigation that can be applied to each spray field. IRZ reported that Hermiston Foods has not irrigated up to the permitted hydraulic loading (ET) rate because: (1) Hermiston Foods does not irrigate until the ET has occurred; (2) farming operations on the fields (e.g. tillage, seeding, fertilizing, spraying, and harvesting) prevent irrigation; and, (3) Hermiston Foods enacted a plan to not irrigate when wind speed is high. IRZ stated that limiting irrigation until ET occurs causes problems at the start of each month. And, the irrigation system is not capable of catching up to

the ET limit at the end of each month. IRZ says the result is that wastewater is stored in the pond and that leads to odor complaints. (Note: DEQ limits hydraulic loading to the ET rate on a monthly basis. It does not require Hermiston Foods to match ET on a daily basis within each month.) In order to be able to irrigate more water, IRZ proposed that DEQ allow Hermiston Foods to use the Checkbook Method of irrigation and limit hydraulic loading to the ET rate on an annual basis.

October 8, 2010. DEQ received Hermiston Foods' response to DEQ's September 22 letter in which twenty-one follow-up questions were posed. In its response, Hermiston Foods proposed to submit its updated odor complaint analyses by October 18. The company reported that all sprinkler drop tubes had been lowered to reflect crop height, that the addition of live bacteria and nitrate compounds to the wastewater system did not result in fewer odor complaints, that the D.O. meter is properly calibrated, that D.O. concentrations are never below 0.5 mg/l in the system, that the company will plant trees around the pond next Spring (2011), that the evaluation of the need for an additional aerator is still ongoing, that the use of vanilla and mint masking agents did not result in fewer odor complaints, and that reducing the line pressure did not result in larger droplets and less misting.

Hermiston Foods reported that during the second alfalfa harvest, too many acres were cut at one time and it took too long for the crop to dry, be baled and removed. The company promised that future hay harvests will be arranged to assure that irrigation can continue on some parcels and that all alfalfa fields are not taken out of production simultaneously to prevent overloading the pond.

The company stated that it would add drag tubes to the outer sections of C-1, C-3, C-5, K4A and K-5. K-2, K-3 and C-2 are already equipped with drag tubes on the outer section. Hermiston Foods reported that data do not support expansion of drag tubes on the full length of pivots for odor control. They said the effect from drag tubes on odor reduction efforts is difficult to evaluate. Moreover, they noted that drag tubes water the crops imperfectly and do not distribute the water adequately to achieve proper crop germination. (Note: the permit requires wastewater to be distributed as evenly as practicable within each field in order to prevent overloading and impact to groundwater. DEQ staff is cautiously concerned about the use of drag tubes compromising our efforts to prevent groundwater impacts.)

Hermiston Foods stated that it is making improvement in the accuracy of its flow measuring. Rather than metering the amount of water and wastewater to each field, Hermiston Foods multiplies the run time of each pivot by the flow rate for that pivot, sums the volume irrigated by each pivot for the month and multiplies it by a flow correction factor to equal the total flow measured at the irrigation sump. Between April and July the flow correction factor varied between 0.87 and 1.27. In its October 8 letter, the company said that the correction factor for August will be 1.02.

Hermiston Foods stated that the pond aerator had been on continuously since the start of taking D.O. measurements. D.O. measurements were started on July 21. (Note: according to data submitted by the company on October 29, the aerator was off for 14 days during that period.)

The company defended its method of doing a D.O. profile of the pond only at the shallow end of the pond by saying that the area at the deep end is rather limited. The outlet from the pond to irrigation is at the bottom of the deep end and DEQ is concerned about the ability of the aerator

to affect the water in the deep end. DEQ will continue to work with Hermiston Foods to get a D.O. profile of the deep end.

October 14, 2010. DEQ received a letter from IRZ Consulting (Hermiston Foods' consultant) that outlined the Checkbook Method of irrigation that was proposed in IRZ's October 8 letter.

October 14, 2010. DEQ had a telephone conference with Hermiston Foods. Linda Hayes-Gorman, Cheryll Hutchens-Woods, Duane Smith and Carl Nadler represented DEQ and Bill Burich, Mark Steele, Roy Stephens and Mark Croeni, along with Bill Hutchison from Roberts Kaplan and Gina Gray from IRZ Consulting, represented Hermiston Foods. During the discussion, IRZ Consulting presented the Checkbook Method and requested that DEQ approve it and extend the period for ET compliance from a monthly basis to an annual basis. DEQ requested Hermiston Foods' soil moisture monitoring results and asked the company to submit the request in writing for DEQ review.

October 18, 2010. Hermiston Foods submitted its updated analyses of odor complaints. The report showed that Hermiston Foods received 116 odor complaints from 16 different neighbors between the time vegetable processing started in 2010 and October 6, 2010. Eighty-nine complaints (77%) came from two neighbors (Walchli (29) and Wallace (60)). Not including the "refused to give name" category, the remaining 23 complaints came from 13 other sources with none of those having more than three complaints. Of the 16 different neighbors, four are located within ¼ mile of the northern boundary of the spray fields. Forty-three percent of the complaints were between 6:00 pm and 8:59 pm; 61% were between 6:00 pm and midnight. Seventy-seven percent of the complaints occurred when wind speeds were low, one to four miles per hour. Sixty-eight percent of the complaints occurred when wind was out of the south, southeast and southwest blowing toward neighbors. However, 28% of the complaints occurred when the wind was out of the west, northwest and north blowing away from neighbors. The number of complaints per day increased as the percent of wastewater being irrigated increased and as the amount of wastewater being stored in the pond increased.

October 19, 2010. DEQ received Hermiston Foods' revised Operations, Maintenance and Management Plan (OM&M Plan), which incorporated the Checkbook Method and proposed that Hermiston Foods meet the ET rate on an annual basis.

October 29, 2010. DEQ received Hermiston Foods' soil moisture monitoring results.

November 1, 2010. DEQ conditionally approved Hermiston Foods' revised OM&M Plan incorporating the Checkbook Method. However, rather than modifying the WPCF permit, which prohibits hydraulic loading in excess of the ET rate on a monthly basis, DEQ agreed in the approval letter to allow Hermiston Foods to demonstrate, during a trial period over the next year, that environmental impacts to groundwater can be avoided with the compliance period extended to two months at a time. During the trial period, Hermiston Foods must continue to report ET and hydraulic loading on a monthly basis. DEQ prefers not to extend the compliance period to a year due to the risk of over-irrigation and leaching in the late season when ET is low. Also in the approval letter, DEQ limited irrigation line pressure to 42 psi (the revised plan provided for 60 psi, although Hermiston Foods previously reported that pump pressure was set at 42 psi to control wind drift of aerosols), prohibited irrigation at wind speeds greater than 30 mph and during any condition that may cause overspray/wind drift to occur (the prohibition had been included in the previously approved OM&M Plan and removed from the recently revised plan)

and required recording wind direction at two locations when investigating complaints (previous plan required two locations, the revised plan only required one location).

November 2, 2010. In response to DEQ's conditional plan approval, Hermiston Foods submitted a written request to reconsider allowing hydraulic loading up to the ET rate on an annual (12-month) basis, to require a wind direction reading from only one wind sock during complaint investigation, and to allow Hermiston Foods' discretion to irrigate at any wind speed.

November 4, 2010. A meeting was held at the EQ offices in Hermiston to talk about creative ways of addressing the odors issue. At the meeting were Lisa Hanson (ODA Deputy Director), Linda Hayes-Gorman (DEQ Regional Administrator), Scott Fairley (Governor's Economic Revitalization Team), Tamra Mabbott (Umatilla County Planning Director), Gina Gray (IRZ Consulting), Mark Croeni (Hermiston Foods), Roy Stephen (Hermiston Foods), Bill Burich (Hermiston Foods) and Bill Hutchison (Roberts Kaplan, attorney for Hermiston Foods). The company presented background and historical information on their business in Hermiston. Discussions covered many topics including land use, measures taken to reduce odors and overspray, the Checkbook method for irrigation, nitrate concerns in the Lower Umatilla Groundwater Management Area, and measures already taken and planned to address odors.

November 4, 2010. DEQ held a second Listening Session at the OSU Experiment Station in Hermiston. Invitations were made to approximately 35 neighbors, however only eight neighbors attended. Also present were Larry Givens (Umatilla County Commissioner), Tamra Mabbott (Umatilla County Planning Director), Gina Miller (Umatilla County Code Enforcement), Melissa Newman (Umatilla County Public Health), Lisa Hanson (ODA Deputy Director), Dan Cain (DHS Public Health), Rick Hill and Phil Richerson (DEQ Hydrogeologists), six representatives from Hermiston Foods (Bill Burich, Mark Steele, Roy Stephen, Craig Williams, Cyd Bothum and Mark Sather) and Gina Gray (Hermiston Foods' consultant from IRZ Consulting).

During the session, Hermiston Foods presented an update of recent and planned improvements to control odors. The company said the ideal situation would be to irrigate wastewater as quickly as possible, but that they had to divert wastewater to the pond because of permit restrictions. They reported that there were 2 to 3 times more odor complaints when wastewater was stored in the pond in the summer. (Note: Hermiston Foods has pointed to the hydraulic loading limit, which limits hydraulic loading from all sources to the ET rate on a monthly basis, as the reason for storing wastewater instead of land applying it. However, it should be pointed out that in the October 8 letter from IRZ Consulting, analysis of irrigation data showed that Hermiston Foods had actually failed to use all available ET. Moreover, Hermiston Foods proposed to use the unused ET from last summer to justify irrigation in November when ET is lower and the risk of leaching during winter storm events is higher.) Hermiston Foods said that they planned to install automation and telemetry on K-3, which would allow for quicker response to odor complaints and changing atmospheric conditions.

Dan Cain from DHS explained that odors may cause subjective (nausea, headache), objective (watery eyes, cough, increased heart rate) and emotional (stress, depression) symptoms and that, unless an odor is toxic, symptoms end when exposure to the odor ends. He said there are lots of variations in reactions to odors and that reactions are affected by individual stress and sensitivity. Women are generally more affected than men. A neighbor stated that it is also a quality of life

issue, that Hermiston Foods' odors produce stress and social disruption. A neighbor asked if the effects of bacteria and mold in wastewater aerosols were known and Mr. Cain said that, according to Public Health Division's toxicologist, there are no known problems with bacteria in aerosols. He said that mold spores are ubiquitous and would be present even if Hermiston Foods wastewater was not there. Mr. Cain said he would do further literature search on bio-aerosol assays.

Hermiston Foods reviewed its analyses of odor complaint records. They reported that most complaints occurred in the evening and that 77% occurred in still winds. They said there were fewer complaints (68%) than expected when the wind was blowing toward neighbors out of the southwest, south and southeast. And, they received 28% of the complaints when the wind was blowing away from neighbors out of the west, northwest and north. A neighbor noted that southwest winds would be carrying odors into uninhabited areas and Hermiston Foods said the company would review the data again. Hermiston Foods apologized to the neighbors for the odors and offered to change irrigation scheduling for special events if neighbors called in advance. A neighbor asked if Hermiston Foods could cover the pond to prevent odors from escaping and Hermiston Foods noted that covering the pond may counteract aeration efforts. Lisa Hanson from ODA suggested contacting Troy Downing, an expert on covering dairy ponds at ODA.

A neighbor asked how they can be sure Hermiston Foods will not cause nitrates in groundwater to increase. Rick Hill (DEQ) explained the groundwater monitoring program at Hermiston Foods site and he and Phil Richerson (DEQ) answered questions pertaining to nitrate contamination in groundwater and the Groundwater Management Area. Rick Hill noted that groundwater nitrate concentrations ranged from 1.8 to 70 mg/L in the area. He identified Hermiston Foods' monitoring well locations on a poster-size site map and explained groundwater flow directions. Mr. Hill stated that DEQ did not allow Hermiston Foods to begin irrigating until the monitoring well network was installed. Duane Smith (DEQ) explained that the purpose of the permit is to protect groundwater by establishing limits on irrigation. Umatilla County Commission Larry Givens asked if it was possible for deep basalt wells to contaminate the alluvial aquifer and Mr. Hill explained that it was unlikely for the basalt wells to contribute anything but cleaner water. Mr. Hill explained that it would take several years of monitoring to establish groundwater quality trends. A neighbor suggested monthly groundwater monitoring during the land application (growing) season and Mr. Hill explained that monthly water levels may be useful, in order to understand fluctuations in groundwater flow direction; but, that monthly groundwater quality monitoring would not useful because the groundwater is not moving fast enough to see a change in groundwater quality from month to month.

A neighbor asked whether Hermiston Foods could be held to a statement it made in a land use hearing regarding blending wastewater with fresh water in a 25/75 ratio. According to Umatilla County Planning Director Tamra Mabbot, the statement could not be enforced because it was not made a condition of land use approval and it is not part of the findings to show compliance with the applicable land use standard.

A neighbor noted that Hermiston Foods' odor complaint responders are rude, deny that odors exist and attribute odors to other sources. Hermiston Foods replied that their responders are not coached and are instructed to truthfully characterize odors. A neighbor noted that dealing with the responders is stressful and that some neighbors refuse to deal with them. Hermiston Foods

countered that the company has and will honor requests to not send responders to visit complainants that do not want to be visited.

A neighbor asked to see data on health effects of spray and odor. Another asked that the neighbors be given contact information for all government representatives at the listening session.

November 5, 2010. Hermiston Foods requested permission to exceed the ET rate on selected fields because the company projects wastewater flows until plant closure to exceed the remaining capacity in the pond. The company estimates that it will need to irrigate about 5 million gallons (MG) in November. In trying to work with the company and ensure groundwater protection, DEQ requested analyses of remaining soil storage capacity, along with projected precipitation and ET during the winter months.

November 9, 2010. Linda Hayes-Gorman explained to Bill Burich at Hermiston Foods that DEQ would not be able to allow the company to exceed the ET rate and violate its permit in order to dispose of the 5 MG. This is for the protection of groundwater.

RESPONSES TO QUESTIONS RAISED AT THE AUGUST 19, 2010 EQC MEETING

Does parking lot storm water and boiler blowdown enter the wastewater system and should that be split to send to the City's wastewater treatment plant to deal with heavy metals? Storm water from employee parking and product receiving areas, boiler blowdown and condenser water are discharged to the industrial wastewater system. Based on knowledge of process, the Department does not expect those waste streams to contain significant concentrations of heavy metals or oil and grease. For the most part, the company's wastewater is derived from processing fresh vegetables. Storm water from employee parking is actually exempt from federal permitting requirements and may be discharged to waters of the State without a permit.

How are DEQ and Hermiston Foods handling the pesticides going to the lagoon and sprayfields? Oregon Department of Agriculture (ODA) regulates pesticide use and only approved chemicals can be put on crops. When Hermiston Foods receives a crop, they also receive a pesticide sheet from the grower that shows all of the chemicals that have been applied to the crop and the dates and times of application. Growers are required to follow label directions, which limit the amount of pesticide applied and time between application and harvest applications prior to harvest. Hermiston Foods also has a Field Dept. consisting of a manager and two field staff that are responsible for crop quality. They track the crops from seed selection through to harvest. Their approval is required for every chemical application, as well as the dwell times between application and harvest.

Why was Hermiston Foods not required to select an alternative to land application? It is not the role of the DEQ or the county to prescribe what process is best for Hermiston Foods, only that whatever process they choose, complies with applicable, adopted laws.

What is the Department doing about overspray and wind drift? The permit prohibits irrigation spray on roads and irrigation ditches. It also prohibits irrigation spray, including wind drift, beyond those lands that have been approved by Umatilla County for land application of Hermiston Foods' wastewater. On June 30, 2010, the Department issued a Warning Letter in response to an overspray complaint from Don Walchli. The Warning Letter required Hermiston Foods to observe a 100-foot setback from all access roads, public roadways and an irrigation ditch located on the northwest edge of field K-1 until the Department approves procedures developed by Hermiston Foods to prevent overspray (see Enforcement Actions, above). Since the Warning Letter was issued, the Department has received only one complaint of overspray. The call was from Neila Wallace on August 5. Hermiston Foods responded by sending a person into the field but they did not observe any overspray.

Why has the Department not pulled the permit yet? The Department's Enforcement Rules are codified at Oregon Administrative Rule Chapter 340, Division 12. The rules require the Department to use increasing levels of enforcement action and to base penalties on the class and magnitude of violation, aggravating and mitigating factors, and the economic benefit realized. To date, there have been no violations that would justify pulling the permit.

Terry Rowan: Mr. Rowan called Carl Nadler one time. It was in June or July after Hermiston Foods began irrigating on the New Site. He talked to Mr. Rowan on the phone and made a telephone memo, but could not find it in the source file. Mr. Nadler recalls from the conversation that Mr. Rowan represented to him that he was acting in his official capacity in the Sheriff's office to complain about odors from Hermiston Foods. He did not complain about a

specific instance of odor or he would have referred the complaint to Hermiston Foods to follow up on. Rather, Mr. Rowan was complaining in general about the odors. Mr. Nadler explained the permit requirements and Hermiston Foods odor management procedures. Mr. Rowan said that he could also do an investigation through the Sheriff's office.

Why does the Department not require setbacks? In order to establish set-backs or buffer zones for wastewater irrigation, the Department must identify a human health hazard or an environmental impact. For instance, recycled municipal wastewater (treated sewage) that is irrigated may contain human pathogens, depending on the level of disinfection. So when permitting irrigation of recycled municipal water, the Department establishes appropriate set-backs to prevent human contact with the pathogens. In Hermiston Foods' case, the wastewater is not known to contain human pathogens or any other contaminant, other than nitrate, in concentrations that may be harmful to humans. Because nitrate is harmful when consumed at concentrations greater than 10 mg/l, the Department established a 400 foot set-back from down-gradient domestic wells. Four-hundred feet is the distance groundwater at the site is expected to travel in two years.

The New Site (Chowning & Koester) is a poorly picked site: From an environmental perspective, the New Site is suitable for land application of food processor wastewater so long as groundwater is protected and nuisance conditions are not created. Hence, the permit includes provisions to protect groundwater and prohibit nuisance conditions, as well as prohibiting run-off and overspray. On the other hand, given the proximity to residential neighbors and the odor generated from wastewater irrigation, the New Site may not be suitable from a land use perspective. However, the Department is not a land use authority. It can only include conditions in permits that comport with the scope of the Department's authority as it pertains to human health and the environment.

There is a concern about food safety with respect to Hermiston Foods' wastewater: Hermiston Foods wastewater contains nitrogen compounds. At concentrations greater than 10 mg/l, orally ingested nitrate can be hazardous to infants. On the other hand, nitrogen is a plant nutrient and land application on food crops is a feasible way to reuse the wastewater, so long as it is done in a manner that is protective of human health and the environment. The Department knows of no human health risk from consuming crops fertilized with nitrate fertilizer or from consuming livestock that consumed crops fertilized with nitrate fertilizer. In general, the Department allows the permittee to select the crops, but then limits the amount of nitrogen that can be applied to the agronomic rate required to grow the crop. In that way, nitrogen that is applied will be used by the crops and groundwater is protected.

Why does the Department rely on Hermiston Foods for self monitoring? We rely on self-monitoring at all permitted facilities because of the costs involved with sampling and analysis. It should be noted that failure to monitor is a Class I violation of the Department's Enforcement Rules and submittal of false reports is a crime.

It appears that something in the wastewater killed the poplar trees: Hermiston Foods planted hybrid poplars at Windblown Ranch several years ago. During the January 8, 2009 inspection, the company informed the Department that a boring insect killed some of the clones. Hermiston Foods' wastewater is not expected to have caused the mortality because it has been used successfully to grow crops for twenty years. When the Department learned the trees were no

longer viable, it prohibited the company from land applying wastewater on them. As a result, the rest of them died.

Phil Richerson says that Hermiston Foods is obviously affecting groundwater: Mr. Richerson performed trend analyses on groundwater conditions at the Windblown Ranch site. He concluded that facility operations impacted groundwater quality there because down-gradient nitrate concentrations exceeded up-gradient nitrate concentrations. On the other hand, Mr. Richerson also concluded that water quality is beginning to improve beneath the Windblown Ranch site because down-gradient trends have recently began decreasing or are less steeply increasing. There is not enough data at the New Site to make conclusions regarding groundwater nitrate trends.

Why would the Department write a Warning Letter on transfer of the permit to the New Site? The Warning Letter was not issued on the transfer of the permit. To facilitate the move to the New Site, the Department modified the permit specifically to address conditions at the New Site. Shortly after the permit modification was issued, and after reviewing Hermiston Foods 2009 Annual Report, the Department issued a Warning Letter to the company for a hydraulic loading rate exceedance at the Windblown Ranch site (see Enforcement Actions, above).

NEXT STEPS

Actions Hermiston Foods has promised to take:

To reduce wind drift/overspray

- Complete an assessment of wind speed and irrigation aerosol drift distance
- Add drag tubes to the outer sections of C-1, C-3, C-5, K4A and K-5

To reduce odors at the pond

- Continue to develop pH, dissolved oxygen (D.O.) and biochemical oxygen demand (BOD) data from the wastewater system
- Plant trees around the pond in the Spring of 2011
- Continue to evaluate the need for an additional aerator in the pond
- Arrange future hay harvests to assure that irrigation can continue on some parcels and that all alfalfa fields are not taken out of production simultaneously to prevent overloading the pond

To reduce odors at irrigation systems

- Review complaint database to confirm the number of complaints when wind is out of the southwest
- Change irrigation scheduling for special events if neighbors call in advance
- Honor complainant's requests to not send responders to visit complainants that do not want to be visited

Other

- Continue to improve the accuracy of flow measurements to the spray fields

Actions DEQ will take:

- Require that a dissolved oxygen (D.O.) profile in the pond be repeated and daily D.O. measurements be continued with a properly calibrated meter
- Based on D.O. monitoring results, discuss with Hermiston Foods the feasibility of:
    - additional aeration or construction of a secondary treatment facility to reduce biochemical oxygen demand (BOD).
    - modifying the outlet pipe from the pond to allow for discharge from the pond at multiple levels
- Contact Troy Downing, an expert on covering dairy ponds at ODA, to discuss the feasibility of covering the pond
- Provide results of DHS literature search to neighbors
- Provide neighbors with contact information for all government representatives at the listening session

Actions DHS will take:

- Literature search on bio-aerosol assays

Actions ODA will take:

- Provide technical contacts for agricultural issues

Summary

DEQ met with neighbors and representatives of other government agencies at the OSU Experiment Station in Hermiston to hear their complaints regarding Hermiston Foods. In general, most complaints pertained to odors, nitrates in groundwater and overspray/wind drift of wastewater.

State of Oregon
Department of
Environmental
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Eastern Region
Water Quality Program
400 E. Scenic Dr.
The Dalles, OR 97058
Phone: (541) 298-7255
(800) 452-4011
Fax: (541) 298-7330
Contact: Carl Nadler
www.oregon.gov/DEQ

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Attendance

Invitations were made to 35 neighbors. Eight neighbors attended.

Also present were:

- Larry Givens, Umatilla County Commissioner
- Tamra Mabbott, Umatilla County Planning Director
- Gina Miller, Umatilla County Code Enforcement Officer
- Lisa Hanson, Deputy Director, Oregon Department of Agriculture (ODA)
- Jim Cramer, Good Agricultural Practices Program Manager, ODA
- Linda Hayes-Gorman, DEQ Eastern Region Administrator
- Cheryll Hutchens-Woods, DEQ Water Quality Manager
- Duane Smith, Waste Water DEQ Permitting Manager
- Carl Nadler, Waste Water DEQ Permit Writer
- William Knight DEQ Office of Communications and Outreach

Concerns

Odor Problems

Neighbors stated that odors from the facility:

- made it hard to breathe
- caused sore throats
- is worse in mornings and evenings
- affects their social lives and families.

Company Response Issues

Neighbors said that Hermiston Foods' responders are:

- slow to respond to complaints
- are offensive
- deny that there are odors
- blame other things such as the complainant's yard, wet hay and the irrigation ditch for the odors
- stand too close to them when they converse

One neighbor said she does not want the responders to knock on her door when they respond.

Groundwater concerns

Neighbors voiced concerns that wastewater leached nitrates into groundwater. One neighbor is buying bottled water because they have measured nitrates in their well water. Neighbors inquired as to why there was so much variability in groundwater nitrate concentrations over the area. DEQ staff provided an overview of ground water contamination and its variability in the Lower Umatilla Basin Ground Water Management Area. DEQ offered to bring back a specialist to address this issue for a next listening session if it was desired.

Commissioner Givens encouraged the neighbors to review the construction of their wells and to check their well logs to determine whether their wells were shallow or basalt wells. This was suggested so that people are familiar with their well's construction.

Potential overspray

There was concern about what is in Hermiston Foods wastewater and whether it could damage crops on adjacent fields through overspray and/or wind drift.

Don Walchli, a neighbor, raises produce in the GAP program. Jim Cramer, from ODA, explained that the US Dept. of Agriculture created the GAP program for growers that wanted to produce certified high-quality crops. The program is voluntary and ODA audits crops in the GAP program in Oregon. In order to meet certification criteria, participating growers must have real-time evidence of everything that goes on the crops. That means that Mr. Walchli must have real-time evidence that chemical and bacterial concentrations in Hermiston Foods wastewater meet the certification criteria if the wastewater is over-sprayed on Mr. Walchli's crops. Absent that information, Mr. Walchli's crops would not meet GAP program requirements.

Mr. Walchli is concerned about bacteria and pesticide in Hermiston Foods wastewater. He said Hermiston Foods should be able to show the neighbors what is in the wastewater, such as pesticides and cleaning products. There was concern that DEQ is not enforcing on overspray/wind drift and that the 15 mph wind speed shut-off was not conservative enough.

Other comments and suggestions

Neighbors said that the wastewater irrigation fields smell bad even after the irrigation has been turned off. They said the pond aerator does not run continuously and the company does not blend sufficient fresh water with the wastewater to control odors.

In general, the level of trust is down because of the recent history.

Next steps

Planning Director Mabbott suggested that the County, State and Hermiston Foods work together on a creative solution such as a land trade to enable land application of wastewater elsewhere far away or grant support for construction of wastewater treatment facilities so the wastewater does not stink. In addition, Planning Director Mabbott suggested a third party check of crop-specific ET rates.

The meeting produced a list of actions that all involved parties could take to help resolve the situation:

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Proposed action items

Action	Owner	Status
Keep aerator on	HF	Aerators are always on unless pond level drops too low
Use consistent 50/50 wastewater/freshwater mix	HF	Water mix varies w/timing of fresh water availability, processing volumes, weather and irrigation needs
Test pond and prove proper aeration in accordance with permit	HF	Testing daily Dissolved Oxygen (DO) content
Reduce solids in waste water	HF	300% smaller screens installed at plant and pond. Using 10/1000" opening
Identify supplemental water source	DEQ, HF	Ditch water and groundwater from wells K-3, C-1 used for blending with wastewater
Characterize contents of wastewater	DEQ, HF	Performed twice monthly for nutrient content
Look into whether covering the ponds is a possibility	DEQ, HF	Possible, but not proposed
Examine creative alternatives such as: GERT, grants, land trade and/or better water treatment	DEQ, Umatilla County	Meeting held with HF, state and local agencies, and representative from Governor's office to discuss options
Look into third party check for ET rates	DEQ, Umatilla County	Using IRZ and Agrimet
Review reports of data/records of land application	DEQ	Reviewed soil moisture
Verify mixing system	DEQ	Done; mixing system in place
Look into reducing 15mph wind cutoff	HF	Assessment in progress for adaptive management model that will shut down areas affected by winds, not whole system
Obtain historic data on nitrate levels in groundwater	Citizens	
Obtain well logs; check wells for construction, depth and water quality history	Citizens	

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Questions and answers from Sept. 28, 2010, listening session

1. Hermiston Foods promised to aerate the wastewater pond to prevent odors; however, we do not hear the aerator running.

Hermiston Foods' records indicate that the aerator was off for 14 days between July 20 and Oct. 24, 2010. Based on company records, Hermiston Foods did not run the aerator on:

- July 21,
- July 25 to July 30,
- Aug. 28 to Sept. 3.

Aerator operational status was not reported on July 20 and July31.

2. Hermiston Foods promised to blend fresh water with wastewater at a rate of 10:1, why are they not doing that?

Hermiston Foods proposed an annual ratio of 80% fresh water, 20% wastewater for irrigation. However, irrigation needs and wastewater flow vary daily. On any given day, the ratio of fresh water to wastewater may be different than the annual loading ratio.

3. Why do nitrate concentrations vary between wells in the area?

Nitrate concentrations in area ground water vary for a number of reasons. One of the primary factors is pollution migrating into the water table from the surface. This commonly results in higher concentrations at the surface of the water table. As groundwater moves, small amounts of contaminants are pulled into deeper portions of the aquifer. Pumping wells located near contamination also tend to pull contaminants deeper into the aquifer. These factors result in uneven mixing in the aquifer. Because of the uneven mixing, neighboring wells frequently have different concentrations. This is especially true for wells screened at different depths.

4. What are the piles east of the wastewater pond?

The piles east of the pond are soil left over from construction of the wastewater pond.

5. Which water supply wells are used for blending?

Groundwater from Wells K-3 and C-1, along with Stanfield Ditch water, is used for blending with wastewater.

6. Can the wastewater pond be covered?

Although it is possible to cover the pond, Hermiston Foods has not proposed to do so. Covering the pond would not eliminate odors from irrigation

Odors from the wastewater pond should be controlled with adequate aeration.

7. How can Hermiston Foods blend fresh water with wastewater without the two streams going through the pond?

Wastewater and fresh water can be mixed in the irrigation sump before irrigation.

8. Are there pesticides and cleaning products in Hermiston Foods' wastewater? If so, how much?

According to Hermiston Foods, the company does not add any pesticides to the process water at the plant. Cleaning chemicals used at the plant are registered and approved for use in food production facilities, and the company verifies that these chemicals are used at the approved concentrations. Any chemicals used by growers in the production of the Hermiston Foods crops are registered and approved by EPA for use. The plant verifies proper adherence to chemical label use before accepting crops from growers.

9. How much nitrate is in Hermiston Foods' wastewater?

The wastewater contains approximately 1.3 mg/L of nitrate. However that could increase to 35 mg/L as wastewater breaks down in the soil. Irrigation with supplemental fresh water reduces the concentrations.

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10. Does Hermiston Foods test its raw products for pesticide residues?
No. Existing regulations do not require the company to test its raw products for pesticide residues. Hermiston Foods states that it requires its growers to apply any chemicals strictly in accordance with the label.

11. Why does Hermiston Foods wastewater stink while wastewater from other food processors does not?
According to Hermiston Foods, all wastewater has an odor. These odors are associated with the type of food being processed (peas, corn, green beans, carrots, potatoes, onions, etc.). Certain conditions may cause stronger odors from process water. For example, diverting a large load of wastewater to a holding pond and storing it for too long in the summer months will cause stronger odors than quickly applying wastewater quickly.

12. Why doesn't Hermiston Foods discharge wastewater to the city sanitary sewer?
Hermiston's city sewers cannot handle the volume of wastewater produced at Hermiston Foods.

13. Why doesn't Hermiston Foods discharge wastewater to the Simplot system?
Hermiston Foods has decided not to discharge their wastewater to the Simplot system because it was being used by another user. DEQ cannot prescribe what process is best for Hermiston Foods. DEQ's role is to ensure that whatever process the company chooses complies with all applicable, adopted environmental laws.

14. Where can neighbors find well logs for their private drinking water wells?
Well logs for private drinking water wells can be obtained from the Department of Water Resources website: http://apps.wrd.state.or.us/apps/gw/well_log/Default.aspx. You will need your tax lot, section, township and range numbers to find the log for your well. Well logs should include information on the depth of your well, whether it is a basalt well or an alluvial well, the depth of the casing and surface seal, and the perforated interval. You should also be able to see the name of the driller, the year the well was drilled, how it was drilled and possibly whether any repairs or modifications have been made.

15. How does DEQ decide how to handle violations and take enforcement action?
DEQ determines the level of enforcement action to take by following statewide guidance found in Oregon Administrative Rule (OAR) 340-012-0045. (e.g. warning letter, monetary penalty or order), based on the likely impact of the violation on human health or the environment. It then adjusts the penalty based on the duration of the violation, the violator's compliance history, their mental state and cooperativeness in achieving compliance, and the economic benefit gained by being in violation.

16. Has Hermiston Foods over-saturated the soil?
Hermiston Foods' permit prohibits irrigating the soil to the point that it creates run-off from the site and leaching below the root zone. The permit requires the company to monitor soil moisture through the root zone. Based on review of soil moisture logs, there was only one instance when the soil was saturated beyond the limits of the permit: K-3NW, a four-acre field exceeded the limit. The company said this occurred because a sprinkler on the field broke.

Summary
DEQ met with neighbors, managers from Hermiston Foods and representatives of other government agencies at the OSU Experiment Station in Hermiston to facilitate direct dialogue between neighbors and the company. The company outlined measures it has taken and plans to take to reduce odors at the plant. Neighbors voiced concerns regarding odors and health risks. A representative from Oregon's Department of Human services made a presentation on the known effects of odors on people, and DEQ provided background information on nitrates in the area and groundwater monitoring practices.

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Invitations were made to 35 neighbors. Eight neighbors attended.

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- Melissa Newman, Umatilla County Environmental Health Supervisor
- Lisa Hanson, Deputy Director, Oregon Department of Agriculture (ODA)
- Linda Hayes-Gorman, DEQ Eastern Region Administrator
- Duane Smith, Waste Water DEQ Permitting Manager
- Carl Nadler, Waste Water DEQ Permit Writer
- Brian Mannion, DEQ Office of Communications and Outreach
- Rick Hill, DEQ Hydrogeologist
- Phil Richerson, DEQ Hydrogeologist
- Daniel Cain, Oregon Department of Human Services, Public Health Division
- Cyd Bothum, Hermiston Foods
- Roy Stephen, Hermiston Foods
- Mark Sather, Hermiston Foods
- Craig Williams, Hermiston Foods
- Gina Gray, IRZ Consulting
- Mark Steel, NORPAC Foods
- Bill Burich, NORPAC Foods

Hermiston Foods Presentation
Odor reduction measures taken:
The company began the meeting with an update of recent and planned improvements to address odor issues at site. According to the presentation, Hermiston Foods took the following actions:

- Replaced screens with fine mesh, both at plant and at wastewater pond
- Installed drop tubes on pivots
- Dropped height of some pivot nozzles to four feet
- Changed some nozzles to make larger water droplets (less likely to cause drift)
- Reduced irrigation pressure from 55 psi to 42 psi
- Experimented with odor-masking agents and "liquid-live" beneficial bacteria for the pond

Planned odor-reduction measures:
Company representatives said Hermiston Foods is considering the following actions in 2011:

- Plant fast-growing hybrid trees around pond to create physical wind barrier
- Apply only fresh water on field S1
- Flush lines to C1 and C2 before harvest
- Explore flushing system with fresh water to lessen time when water stands in tubes
- Test for need for more aeration
- Assume more direct involvement in irrigation (currently handled by contractor)
- Install a new automation system for K-3 pivot
    - Includes wind monitoring and automated stop/start
    - Could allow faster response to odor incidents

Complaint data:
Hermiston Foods said it has logged all complaints it receives including the name of complainant, time of complaint and weather conditions at the time of complaint. Their analysis found that 77 percent occurred in still weather, most complaints occurred in the evening, complaints are correlated to wind direction and twice to three times as many complaints were filed when wastewater was stored in the pond during summer months. The company said it was still looking at the numbers to identify trends and relationships between weather patterns, irrigation practices and complaints.

Other comments, responses:
Throughout their presentation, Hermiston Foods answered questions from neighbors and presented company views on a range of subjects. The company maintained that the best solution to reduce odors is to apply the waste water directly to fields without storing it, but that DEQ regulations limited the amount of water they could apply and required storage of waste water.
In response to questions, Hermiston Foods said that they investigated the possibility of using the Simplot system, but found that it was being used by another user. The company has not looked into onsite purification measures for financial reasons, and Hermiston Foods will continue to work to reduce odors and with what is proposed for 2011, they would expect odors to be reduced.

When asked about covering the storage pond to reduce odors, the company said that covering might counteract the positive effects of aeration.

Hermiston Food representatives asked neighbors to call the company and give them advanced notice of social events and gatherings so that they can regulate irrigation activities to minimize the potential of odors reaching neighbors.

DHS Odor Presentation
DHS Industrial Hygiene Specialist Dan Cain presented information regarding the effects of odors. This presentation included the following information:

- Odors may cause subjective, objective and emotional symptoms
    - Subjective: nausea, headache

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  - Objective: watery eyes, cough, increased heart rate
  - Emotional: stress, depression
- Unless material is toxic, symptoms end when exposure to the odor ends
- Reactions to odors vary greatly; reactions are affected by other factors including response to stress and sensitivity; women are generally more affected than men

Neighbors asked if there is any risk from airborne bacteria or mold from the spray. Cain said that DHS toxicologists say there is no known risk from this type of land application, but that he would perform a literature search to see if any studies address the issues specifically.

DEQ groundwater information

Neighbors asked how they can be sure Hermiston Foods' activities were not contributing nitrates to their groundwater. In response, DEQ staff provided the following information:

- The entire area is situated in a water quality management area, so it is not uncommon to see higher nitrate levels in management area.
- Base data for area shows wide range of nitrate levels (1.95 - 71 mg/liter); higher levels this year cannot be attributed to Hermiston Foods activities at the site because not enough time has passed for irrigation water to travel into ground water.
- DEQ showed location of 11 test wells on map and explained groundwater movement patterns.
- DEQ explained that test well data was a baseline (obtained before irrigation) because the agency did not let Hermiston foods apply wastewater before installing test wells; three samples taken before land application began.
- The purpose of the permit is to protect groundwater by limiting irrigation.
- It is unlikely that basalt/confined aquifers contributed anything but clean water to test wells.
- Testing has not detected significant drift of nitrates.
- Years of testing data still needed to identify any trends.

Neighbors suggested monthly groundwater monitoring through growing season. DEQ staff explained that groundwater moves at a slower pace, so monthly monitoring would not allow enough time to detect changes in the groundwater attributable to Hermiston Foods' actions. They suggested continuing quarterly monitoring and explained that it would take years of data to identify any groundwater trends.

Neighbor concerns

Neighbors reiterated a number of concerns that they expressed in the September 28 meeting:

- Odor Problems
- Company Response Issues
- Groundwater Concerns
- Potential Overspray
- Affects quality of life and property values

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The neighbors also asked about the potential risk of airborne bacteria and mold from using waste water in irrigation.

Other comments and suggestions

Neighbors asked for a contact list containing information for all government representatives who attended the meeting. They also asked that the complaint and frequency of complaints be plotted on a map of the area.

Next steps

DEQ, DHS and Hermiston foods all agreed to some type of action to address neighbors' concerns, as seen in the table below.

Action	By	Status
Include wind data for all days in complaint data	Hermiston Foods	To be done
Plot complaints (number and type) on full area map	Hermiston Foods	To be done
Notify Hermiston Foods of upcoming events/gatherings at nearby homes	Neighbors	Ongoing
Modify irrigation schedule where possible to accommodate neighbor's social events as requested.	Hermiston Foods	Ongoing
Make test well data available	DEQ	Data is public record. Residents may contact DEQ for more information (see contact information for Carl Nadler on front page)
Contact Troy Downing to discuss how dairy farms deal with odors; report back to group	DEQ/ Hermiston Foods	To be done
Send neighbors contact info for all specialists/government reps involved in meeting	DEQ	Done via email 11/5/10
Perform literature search regarding effects/risk of bacteria and mold in water mist; report findings to neighbors	DHS	To be done

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State of Oregon
Department of Environmental Quality Memorandum

Date: Feb. 7, 2011

To: Environmental Quality Commission

From: Dick Pedersen, Director

Subject: Agenda item B, Informational and discussion item: DEQ's and Hermiston Foods' efforts to address neighbors' complaints about odors and overspray from Hermiston Foods' process wastewater land application
February 16-18, 2011, EQC meeting

Purpose of item

DEQ will update the commission on progress made towards reducing odors and overspray from Hermiston Foods' land application of process wastewater.

Why this is important

Neighbors near Hermiston Foods land application property report that strong odors are negatively affecting their quality of life, threatening property values and possibly contaminating their groundwater. Since June 2010, 15 neighbors have lodged multiple complaints about odors and overspray with the company. Several neighbors addressed the commission at the August 2010 and October 2010 EQC meetings expressing their concerns and frustrations with DEQ's and the company's responses to their complaints. The previous land application site, known as the Windblown Ranch, and the new site, Chowning and Koester, are located within the Lower Umatilla Basin Groundwater Management Area, which is designated a management area based on elevated groundwater nitrate concentrations.

Background

Hermiston Foods has operated a vegetable processing plant and an industrial wastewater treatment facility south of Hermiston since 1990. Unlike other vegetable processors in the area that operate year-round to process potatoes, the Hermiston Foods plant operates seasonally to process asparagus, peas, sugar snap peas, carrots and lima beans. Wastewater is generated from vegetable processing, washing, grading, and transporting. Hermiston Foods generates approximately 100 million gallons of wastewater annually, mostly between June and November. During the balance of the year, the plant is idle with equipment maintenance, testing and refinement of the processing operation. Sanitary sewage is discharged to the Hermiston sewage treatment plant. Hermiston Foods' wastewater contains nitrogen compounds that can be beneficially reused by irrigation on agricultural crops. Between 1990 and 2009, Hermiston Foods operated a land application program on the Windblown Ranch site. The site included a plastic-lined three million

gallon surge pond, a pump station, flow meters, two 125-acre center-pivot irrigation circles and 14.6 acres of hybrid poplar trees. Seven groundwater monitoring wells were used to monitor impacts to the shallow groundwater aquifer at the Windblown Ranch site.

On Jan. 8, 2009, Hermiston Foods notified DEQ that it intended to move its wastewater storage lagoon and land application activities from Windblown Ranch to the new site, which consisted of the Chowning and Koester Farms and totaled 511.33 acres, of which 476 acres are irrigated. Hermiston Foods proposed and DEQ approved plans to construct a 10 million gallon, polypropylene-lined wastewater pond at the new site. The plans included aeration to control odors. Twelve groundwater monitoring wells were installed at the new site to monitor impacts to the shallow groundwater aquifer.

Additional considerations: hydraulic loading

In order to prevent nitrate leaching below the root zone and adverse impact to groundwater, DEQ limits hydraulic loading from all sources including precipitation and supplemental water to the crop-specific evapotranspiration rate on a monthly basis. By matching hydraulic loading to the crop-specific evapotranspiration rate, the receiving crops get the water they need, when they need it, without overloading the soil and causing leaching to groundwater. This is important because of the already-elevated groundwater nitrate concentrations in the Lower Umatilla Basin.

Although the size of the pond and land application areas increased with the move to the new site, Hermiston Foods stated that the volume of wastewater will not increase and that nitrogen loading should be reduced because of the larger volume of the new site's wastewater pond. However, for a number of operational and crop management reasons, Hermiston Foods projected that it would exceed its wastewater system capacity before the end of the 2010 processing season.

In October 2010, the company and its irrigation engineering consultant, IRZ Consulting, proposed that DEQ allow Hermiston Foods to use the checkbook method of irrigation and limit hydraulic loading to the evapotranspiration rate on an annual, as opposed to monthly, basis. The permit currently requires a monthly basis. The company states that DEQ's hydraulic loading restrictions caused Hermiston Foods to store wastewater in the pond, resulting in odor complaints and stressing the crops.

Evapotranspiration decreases at the end of each growing season and in November 2010, Hermiston Foods requested permission to exceed the evapotranspiration rate on selected fields because they projected

wastewater flows until plant closure to exceed the remaining capacity in the pond. The company estimated that it would have about five million gallons in November that would need to be irrigated.

DEQ worked in earnest with the company to find a solution for more wastewater application during the end of the irrigation season. DEQ requested analyses of remaining soil moisture storage capacity, along with projected precipitation and evapotranspiration during the upcoming winter months. DEQ, however, determined that additional irrigation at that time would violate the permit's hydraulic loading limit that is designed to protect groundwater. DEQ had already issued the company a warning letter earlier in 2010 for exceeding its hydraulic loading permit provisions, and explained that a second such violation within a 36-month period would likely result in civil penalties.

The company stated that it had limited options to manage the anticipated remaining process wastewater, and that it might have to shut down the facility and sell the remaining carrot harvest if its pond storage capacity was reached. In the end, Hermiston Foods reached pond storage capacity, shut down early and rejected crop deliveries from growers who then had to find other buyers or absorb the loss.

During the winter months of December 2010 and January 2011, DEQ worked with Hermiston Foods and their consultants to find flexibility that will allow for a viable crop without knowingly increasing the potential for leaching to occur. A more flexible method that mixes the use of soil moisture and evapotranspiration has been agreed on and the details are being worked out in the company's Operations, Management and Maintenance Plan and their permit will be modified to allow these changes.

In the meantime, a special one-time allowance has been made to parse out the stored process water in the company's pond during February so that water levels will be reduced in time for processing to start up again in March. DEQ reviewed current moisture data for the soil on site and determined there is currently capacity to safely accept moisture in several crop circles. Unfortunately, immediately upon reactivation of the aerator and irrigation in the first week of February 2011, DEQ and Hermiston Foods have received odor complaints.

Report to EQC

At the August 2010 EQC meeting, the commissioners requested that DEQ provide a written summary of the history, permit activity, response to complaints, answers to the questions asked during the commission meeting and a path forward.

In summary, the following regulatory activities related to Hermiston Foods have occurred between December 1989 and January 2011:

- One permit issuance, three permit renewals, and three permit modifications
- No complaints received between June 1996 and 2009
- 154 complaints received by Hermiston Foods from June 14, 2010, to Nov. 17, 2010, of which 71 percent were from two residences
- Eight compliance inspections since permit issuance
- Six enforcement actions, including:
    - 11/8/96: Notice of noncompliance - Failure to land apply in accordance with permit conditions
    - 3/3/08: Warning letter - Nitrogen loading in excess of approved agronomic rate
    - 2/10/09: Warning letter - Nitrogen loading in excess of approved agronomic rate; failure to certify annual report
    - 11/24/09: Warning letter - Irrigating 35,000 gallons on a site not permitted for land application
    - 3/16/10: Warning letter - Hydraulic loading rate exceedance
    - 6/30/10: Warning letter - Allowing irrigation to leave permitted site (overspray on road)

A full report of the above items, including answers to questions posed by neighbors during the August 2010 EQC meeting, is provided in attachment A.

Public involvement

DEQ invited 35 neighbors, with contact information provided by Hermiston Foods' complaint log, DEQ's complaint log and the Umatilla County Land Use hearing records, to a Sept. 28, 2010, listening session at the Oregon State University Experimental Station in Hermiston. Eight neighbors attended. DEQ also invited Lisa Hanson, deputy director of Oregon Department of Agriculture, Jim Cramer, Oregon Department of Agriculture's Good Agricultural Practices program manager, Umatilla County Commissioner Larry Givens; Umatilla County Planning Director Tamra Mabbott and Umatilla County Code Enforcement Officer Gina Miller.

The agencies listened to concerns from the neighbors and answered

their questions. Most concerns pertained to odors, nitrates in groundwater, and overspray or wind drift of wastewater. A summary of the meeting can be found in attachments A and B. Answers to questions raised during the listening session can be found attachment C.

DEQ held a second listening session Nov. 4, 2010, and invited 35 neighbors and Hermiston Foods to the session at the Hermiston OSU Experimental Station. Again, eight neighbors attended; however, not all the same neighbors attended as did for the first listening session. DEQ invited Lisa Hanson, Daniel Cain, Department of Human Services Public Health Division, Umatilla County Commissioner Larry Givens Umatilla County Planning Director Tamra Mabbott, Umatilla County Code Enforcement Officer Gina Miller and Umatilla County Environmental Health Supervisor Melissa Newman. Seven Hermiston Foods/NORPAC representatives and one IRZ representative attended. In general, neighbors stated concerns of odors, groundwater contamination, overspray, concerns about bacteria and mold in the irrigation water, and reduced quality of life and property values.

Summary notes of this meeting can be found in attachment A and attachment D.

Analyzed odor complaints

Hermiston Foods analyzed information obtained from their odor complaint logs. Of the 154 complaints received this last season, 71 percent come from two nearby residences. Most complaints came in the evenings when wind speeds were low and from the south. Data shows complaints increased notably during summer months when the amount of process water in the pond increased.

Actions taken to reduce odors and overspray

To date, Hermiston Foods has taken the following actions to address odor issues and overspray:

- Replaced plant and wastewater pond screens with fine mesh (0.010") which reduces solid particles entering the system.
- Experimented with odor-masking agents and "Liquid-Live" beneficial bacteria for the pond.
- Lowered drop tubes on irrigation systems commensurate to crop height.
- Installed drag tubes on some center pivots.
- Reduced height of some pivot nozzles to four feet.
- Selected irrigation nozzles that produce larger water droplets that are less likely to cause wind drift.
- Reduced irrigation system operating pressure from 55 to 42 psi.

Next steps

Hermiston Foods has committed to:

Reduce wind drift and overspray

- Lower more of the sprinkler nozzles next to the perimeter areas, and/or use more drag tubes
- Manage irrigation according to wind velocity and direction

Reduce odors at the pond

- Continue to develop pH, dissolved oxygen and biochemical oxygen demand data from the wastewater system
- Plant trees around the pond and neighboring residences in spring 2011
- Research planting field S-1 with peppermint (borders neighboring residence)
- Continue to evaluate the need for an additional aerator in the pond

Reduce odors at irrigation systems

- Arrange future alfalfa harvests to assure that irrigation can continue on some parcels and that all alfalfa fields are not taken out of production simultaneously to prevent overloading the pond
- Conduct a trial on flushing irrigation systems with fresh water when they will be down for extended periods of time
- Discontinue up-wind irrigation, if possible, if the neighbors notify company in advance that they are having a special social event.
- Automate operation and data gathering on part of the irrigation system.
- Continue analysis of odor complaints and look for effective and efficient methods to minimize odors.

Other

- Continue to improve the accuracy of flow measurements to the spray fields

Actions DEQ will take:

- Require that a dissolved oxygen profile in the pond be repeated and daily measurements be continued with a properly calibrated meter. Dissolved oxygen is used as a measure to detect aerobic/anaerobic conditions in water. Unpleasant odors can increase when conditions are anaerobic.
- Based on dissolved oxygen monitoring results, discuss with

Hermiston Foods the feasibility of:
  - Additional aeration or construction of a secondary treatment facility to reduce biochemical oxygen demand.
  - Modifying the outlet pipe from the pond to allow for discharge from the pond at multiple levels
- Contact Troy Downing, an expert on covering dairy ponds at the Oregon Department of Agriculture, to discuss the feasibility of covering the pond (a joint site visit with Troy is scheduled for Feb. 9, 2011)
- Provide results of Department of Human Services literature search to neighbors.
- Provide neighbors with contact information for all government representatives at the listening session (completed)
- Continue working with the company and neighbors for a result that all can live with.

Actions DHS will take:
- Literature search on bio-aerosol assays (completed)

Actions ODA will take:
- Provide technical contacts for agricultural issues (completed)

EQC involvement

DEQ will provide informational updates on the progress of this effort at the pleasure of the commission.

Attachments

A. Report to EQC: Hermiston Foods
B. Meeting notes: Sept. 28, 2010, listening session
C. Questions and answers: Sept. 28, 2010, listening session
D. Meeting notes: Nov. 4, 2010, listening session

Report prepared by: Linda Hayes-Gorman
Phone: 541-633-2018

HERMISTON FOODS

Submitted to: **Linda Hayes-Gorman**
Eastern Region Administrator

By: **Duane A. Smith**
Carl Nadler

State of Oregon
Department of
Environmental
Quality

Nov. 10, 2010

Updated Jan. 24, 2011

FACILITY DESCRIPTION and HISTORY

Since 1990, Hermiston Foods has operated a vegetable processing plant and an industrial wastewater treatment facility south of Hermiston. Unlike other vegetable processors in the area that operate year-round to process potatoes, the Hermiston Foods plant operates seasonally to process asparagus, peas, sugar snap peas, carrots and lima beans. Wastewater is generated from vegetable processing, washing, grading, and transporting. Boiler blow-down, condenser water and storm water are also discharged to the treatment facility. Hermiston Foods generates approximately 100 million gallons of wastewater annually, mostly between June and November. During the balance of the year, the plant is idle with equipment maintenance, testing and refinement of the processing operation. Sanitary sewage is discharged to the Hermiston sewage treatment plant.

Principal components of Hermiston Foods' wastewater treatment system include side hill screens, sediment basins, concrete lined gutter flush system, collection sump and pump station, an underground pipeline and land application system that includes a storage pond.

Process-related residual solids, or waste solids, consist of asparagus greens, pea pods, reject peas, carrot greenery, carrot reject scraps, rock, silt and tare dirt. Vegetable waste solids, including vegetable solids from the screens, are utilized offsite as livestock feed. Rock, silt, and tare dirt are returned on a pro rata basis to the individual growers who supply raw carrots to the plant.

Hermiston Foods' wastewater contains nitrogen compounds that can be beneficially reused by irrigation on agricultural crops. Between 1990 and 2009, Hermiston Foods operated a land application program on the Windblown Ranch. The site included an HDPE-lined three million gallon surge pond, a pump station, flow meters, two 125-acre center-pivot irrigation circles, and 14.6 acres of hybrid poplar trees. Seven groundwater monitoring wells were used to detect impacts to the shallow groundwater aquifer at the Windblown Ranch site.

On Jan. 8, 2009, Hermiston Foods notified DEQ that it intended to move its wastewater storage lagoon and land application activities from Windblown Ranch to the New Site, which consisted of the Chowning and Koester Farms and totaled 511.33 acres, of which 476 acres are irrigated. Hermiston Foods proposed, and DEQ approved, plans to construct a 10 million gallons, polypropylene-lined wastewater pond at the New Site. The plans included aeration to control odors. Twelve groundwater monitoring wells were installed at the New Site to detect impacts to the shallow groundwater aquifer.

Although the size of the pond and land application areas increased with the move to the New Site, Hermiston Foods has stated that the volume of wastewater will not increase. Hence, it should be easier for the company to comply with nitrogen loading limits at the New Site. This is significant because both Windblown Ranch and the New Site are located within the Lower Umatilla Basin Groundwater Management Area, which was designated as such based on elevated groundwater nitrate concentrations over a widespread area.

PERMIT HISTORY

Effective Date	Action
Dec. 22, 1989	Permit issuance. The permit prohibited discharge to surface waters and required the permittee to land apply wastewater in accordance with a DEQ-approved wastewater management plan. In addition, the permit limited objectionable odors, flies, mosquito breeding, other nuisance conditions and leaching of nitrogenous compounds. Groundwater contamination was prohibited. Wastewater facility and groundwater monitoring was required in accordance with the approved plans. Expiration date: Dec. 31, 1994.
June 18, 1996	Permit renewal. The permit prohibited nitrogen loading in excess of the maximum agronomic rates established by Oregon State University fertilizer guides and it prohibited leaching below the root zone. Provisions for storm water disposal in dry wells, or underground injection controls, were included in the permit. Specific groundwater monitoring requirements were included in the permit; however, wastewater facility monitoring was required to be in accordance with the approved operations, monitoring and management plan. The permit required submittal of revised operations, monitoring and management plans and groundwater monitoring plans, along with submittal of a water quality analysis report with proposed groundwater concentration limits. Expiration date: May 31, 2001
Sept. 5 and Sept. 17, 1996	Permit modifications. DEQ modified the permit on two occasions to extend compliance dates for submittal of revised operations, monitoring and management plans and groundwater monitoring plans.
Feb. 14, 1997	Permit modification. DEQ modified the permit to extend the compliance date for submittal of a water quality analysis report with proposed groundwater concentration limits for the Windblown Ranch site.
April 1, 2004	Permit renewal. The permit established groundwater concentration limits for total dissolved solids, nitrate-nitrogen and chloride in monitoring well MW-4. Specific facility monitoring requirements were included in the permit and the list of required groundwater monitoring parameters was increased. An additional groundwater monitoring well was required to be installed and a water quality analysis report with proposed groundwater concentration limits was required for the new monitoring well. Expiration date: March 31, 2009
Aug. 25, 2009	Permit renewal. Hydraulic loading was limited to the crop-specific evapotranspiration rate. Odor monitoring, control and complaint response procedures were required to be included in the operations, monitoring and management plan. The permit required closure of the wastewater pond at Windblown Ranch. Accumulated sediments were required to be removed and a characterization of the soil beneath the liner was required.

Expiration date: Dec. 31, 2015

March 5, 2010 Permit modification. The permit was modified to allow land application of wastewater at the New Site. Comments that were made during Umatilla County's public hearings on land use and received during the last permit renewal were addressed in the modification.

- Ponding that lasts up to 24 hours after irrigation has stopped was allowed only if adverse or nuisance conditions do not occur as a result.
- Irrigation spray, including wind drift, was prohibited beyond lands described in the County-approved land use compatibility statement.
- Irrigation spray was prohibited on roads, irrigation ditches, and well heads that are not protected by well houses.
- Irrigation spray was prohibited within 400 feet of all downgradient domestic wells, unless otherwise approved in writing by DEQ.
- Groundwater monitoring and the establishment of groundwater concentration limits were required.
- Hermiston Foods' tenant's well was required to be monitored on a quarterly basis for nitrate-nitrogen for two years.
- Prior to irrigating, wells located in sprayfields were required to be abandoned or have well houses constructed over them.
- Prior to irrigating, all underground piping was required to be leak tested.
- Prior to irrigating, drop tubes with low-pressure nozzles were required to be installed on all pivot irrigation equipment.
- Prior to irrigating, a swing arm on Field K-3 was required to be removed. DEQ had observed ponded water in wheel ruts on that field. During the land use hearings, Hermiston Foods stated that the nozzles on the swing arm malfunctioned and did not shut off near Canal Road causing ponding. The company promised to remove the swing arm from the pivot and the condition was included in the permit modification.
- Prior to irrigating, a ponding problem in Field C-5 was required to be remedied.
- Prior to irrigating, eight new monitoring wells were required to be installed around the perimeter of the New Site bringing the total number of wells to twelve.

COMPLIANCE HISTORY

Complaints
Between June 1996 and June 2009, DEQ did not receive any complaints regarding the facility.

Inspections
DEQ conducted compliance inspections of the facility on Aug. 19, 1997, Oct. 12, 1998, June 6, 2001, June 28, 2002 and Jan. 8, 2009. No violations were documented during the inspections.

On June 23, 2010, DEQ inspected the new facility and documented two violations: Irrigation spray on the east boundary road and an end gun on Field K-3 pivot. Both violations were addressed in a June 30, 2010 warning letter. See enforcement actions section, below, for more detail.

On July 12, 2010, DEQ inspected the facility. No wind drift was observed leaving the property and the pivots appeared to have been modified to observe the 100-foot setback.

On Aug. 27, 2010, DEQ inspected the facility during seven mile per hour winds and observed irrigation spray blowing across a field, however it did not leave the property. An unpleasant wastewater smell was also noted at the irrigation field.

Enforcement actions
On Nov. 8, 1996, DEQ issued a Notice of Noncompliance to Hermiston Foods for failure to land-apply wastewater in accordance with permit requirements. The company had reported a weekend overflow of the surge pond and a release of approximately 36,000 gallons to an uncropped area. There was no discharge to waters of the state. The violation was a Class II violation of DEQ's enforcement rules. To ensure that the violation did not recur, Hermiston Foods was required to perform visual inspections of the surge pond every Saturday morning.

On March 3, 2008, DEQ issued a Warning Letter to Hermiston Foods for nitrogen loading in excess of the approved agronomic rate. It was a Class II violation of DEQ's enforcement rules. Hermiston Foods was required to ensure that wastewater was managed in accordance with permit requirements.

On Feb. 10, 2009, DEQ issued a Warning Letter to Hermiston Foods for nitrogen loading rate exceedances and for failing to certify its annual report. Nitrogen loading rate exceedances within groundwater management areas are Class I violations. Failure to certify the report is a Class II violation. To correct the nitrogen loading rate violation, the company was prohibited from land applying wastewater on the hybrid poplars, which were no longer viable and was required to ensure that nitrogen from all sources did not exceed the agronomic rates for the receiving crops. To correct the certification violation, the company was required to re-submit the annual report with a certification. In addition, as a result of the Class I violation, DEQ issued Hermiston Foods a Notice of Permit Violation and required to certify that the company was operating in compliance with its permit or to submit a proposal to bring the facility into compliance with the permit. On March 16, 2009, DEQ received Hermiston Foods certification that it was operating in compliance with its permit.

On Nov. 24, 2009, DEQ issued a Warning Letter to Hermiston Foods for irrigating approximately 35,000 gallons of wastewater on a site that was not permitted to receive

wastewater. The violation occurred following a break in the wastewater pipeline. In order to repair the break, the company drained the pipeline back to the plant and land applied the wastewater on an undeveloped field south of the plant. The violation was a Class II violation. Hermiston Foods was required to ensure that all wastewater management and disposal activities were in accordance with the permit and approved operations, maintenance and management plan.

On March 16, 2010 after reviewing Hermiston Foods 2009 Annual Report, DEQ issued a Warning Letter to the company for a hydraulic loading rate exceedance at the Windblown Ranch site. Exceedance of a hydraulic loading limitation is a Class II violation. The company was required to ensure that wastewater management and disposal activities are in accordance with the permit and approved operations, maintenance and management plan.

On June 30, 2010, DEQ issued a Warning Letter to Hermiston Foods for allowing irrigation spray on the east boundary road. The violation was a Class II violation. As a result, Hermiston Foods was required to observe a 100-foot setback from all access roads, public roadways and the irrigation ditch located on the northwest edge of field K-1. Irrigation of process wastewater was prohibited at wind speeds that cause wind drift beyond property boundaries. In addition, Hermiston Foods was required to prepare and submit detailed procedures designed to prevent irrigation spray, including wind drift, from affecting roads, irrigation ditches and adjacent properties. Plans and procedures were required to include provisions for preventing variable wind speed and direction from causing wind drift in violation of the permit. Lastly, Hermiston Foods was required to remove all impact-type end guns from all pivots. The setbacks and irrigation prohibition were required until such time DEQ approved procedures developed by Hermiston Foods to prevent violation of the permit. On Aug. 5, 2010, DEQ conditionally approved Hermiston Foods' proposal to install drag tubes on the outer 100 feet of pivot equipment affected by the setback. The approval letter provided that upon installation, the set-backs would be deemed removed and irrigation in the setback would be permitted.

Chronology of recent events and activities

Jan. 8, 2009. Carl Nadler and Rick Hill, from DEQ, met with Mark Steele, Craig Williams, Roy Stephens and Bill Burich, from Hermiston Foods, at the Hermiston Foods processing plant to discuss site authorization of the new Chowning and Koester land application sites. The contract at the old site (Windblown Farms) was to expire at the end of 2009.

Jan. 15, 2009. DEQ received Hermiston Foods' application for renewal of its water pollution control facility permit.

Feb. 10, 2009. DEQ issued a Warning Letter to Hermiston Foods for nitrogen loading rate exceedances and for failing to certify its annual report. The facility is located within the Lower Umatilla Basin Groundwater Management Area and nitrogen loading rate exceedances within groundwater management areas are Class I violations. As a result, DEQ issued Hermiston Foods a Notice of Permit Violation and required to certify that the company was operating in compliance with its permit or to submit a proposal to bring the facility into compliance with the permit. On March 16, 2009, DEQ received Hermiston Foods certification that it was operating in compliance with its permit.

May 6, 2009. DEQ issued a discussion draft of water pollution control facility renewal permit to Hermiston Foods.

June 2, 2009. Carl Nadler and Duane Smith, from DEQ, met with Mark Steele, Craig Williams, Roy Stephens and Bill Burich, from Hermiston Foods, in DEQ's The Dalles office to discuss the draft renewal permit.

July 2, 2009. DEQ issued a public notice request for comments on Hermiston Foods' draft renewal permit.

July 13, 2009. A neighbor of the proposed site called DEQ regarding concern that Hermiston Foods' proposed new land application sites would affect the water quality in his wells. Carl Nadler advised Craig Williams to locate all domestic wells by going door-to-door.

Aug. 3, 2009. The comment period closed on Hermiston Foods' draft water pollution control facility renewal permit for the Windblown site. DEQ received comments from eighteen individuals. However, during that time, Umatilla County Planning Department also invited public comment regarding land use to allow land application of wastewater at the Koester and Chowning sites. Because of the two comment periods overlapping, many of the comments received by DEQ pertained to the land use decision (e.g. whether land application of industrial wastewater should be allowed near residences, the effect that will have on property values and whether alternatives were considered). DEQ explained that comments pertaining to the land use decision must be directed to Umatilla County Planning Departmnent; and that if the land use decision is approved, the draft water pollution control facility permit will have to be modified to incorporate the Chowning and Koester sites. DEQ explained that, at that time, public comments would be accepted on those sites. The most common comments received pertained to concerns about odors or air pollution from the wastewater system and potential groundwater contamination from nitrates. Other comments were repeated less frequently. Similar types of comments (e.g. odor or groundwater contamination) were combined into single generic comments and DEQ drafted responses.

Aug. 25, 2009. DEQ issued Hermiston Foods' water pollution control facility permit renewal for the Windblown Ranch.

Sept. 3, 2009. DEQ approved Hermiston Foods' proposal to remove accumulated sediments from the old pond and land apply slurry of approximately two million gallons on 70 acres of fallow ground at the old site. DEQ warned Hermiston Foods that it had recently received odor complaints and that if odors become an issue during the pond sediment removal operation Hermiston Foods was expected to respond appropriately to them.

Sept. 24, 2009. The Umatilla County Planning Commission took public comments at a land use hearing and conditionally approved Hermiston Foods' request to apply wastewater on the Chowning and Koester sites.

Nov. 3, 2009. The Umatilla County Commission held a land use appeals hearing and upheld the Planning Commission's decision, but removed some of the conditions the Planning Commission had imposed. The county commissioners requested Planning Staff to prepare a letter to DEQ recommending that DEQ consider and address public comments that could not be addressed by the county. Most of the comments pertained to odor and groundwater nitrate concerns. There were also concerns about set backs or buffers. Mark Steele stated that Hermiston Foods was going to install drop tubes to control wind drift.

Nov. 24, 2009. DEQ issued a Warning Letter to Hermiston Foods for a plan violation. The company's wastewater pipeline broke between the plant and the Windblown Ranch site. The company drained the pipe back to the plant and land applied the wastewater on a field south of the plant that was not approved for land application. The violation was a Class II violation. The company expressed a plan to obtain land use approval and DEQ site authorization permitting as a precautionary measure for future emergency use.

Nov. 24, 2009. DEQ issued a site authorization letter to Hermiston Foods for the Chowning and Koester sites. The authorization required all wastewater storage and land application activities to be conducted in accordance with the water pollution control facility permit and DEQ-approved plans. It prohibited irrigation spray, including wind drift, beyond the lands described in the Land Use Compatibility Statement. It prohibited irrigation spray on roads, irrigation ditches, and well heads that are not protected with well houses. It prohibited irrigation spray within 400 feet of all downgradient domestic wells, unless otherwise approved in writing by DEQ. It also required that odor monitoring, control and complaint response procedures shall be included in the DEQ-approved plan and implemented by Hermiston Foods.

Nov. 24, 2009. DEQ modified Hermiston Foods' water pollution control facility permit to cover the Chowning and Koester land application sites and issued a discussion draft of the permit modification to Hermiston Foods. The permit modification required Hermiston Foods to drill four replacement groundwater monitoring wells, since original wells were screened too deep, two new groundwater monitoring wells between the spray fields and neighboring wells, and two new groundwater monitoring wells on the eastern downgradient side of the Koester site.

Dec.7, 2009. Carl Nadler and Duane Smith, from DEQ, met with Mark Steele, Craig Williams, Roy Stephens, Bill Burich and Steve Mueller, from Hermiston Foods, in DEQ's Pendleton office to discuss the draft permit modification.

Dec. 23, 2009. DEQ issued the formal applicant review draft of the permit modification to Hermiston Foods.

Dec. 24, 2009. DEQ issued a special permit to Hermiston Foods to temporarily operate the new pond until the permit modification is issued. The permit was necessary because the company needed the new pond for storage while in the process of abandoning the old pond.

Jan. 14, 2010. A neighbor told Carl Nadler that he has a domestic well for a migrant camp approximately 200 yards downgradient of field K-3. He said he would get the GPS coordinates to DEQ. Carl Nadler informed Hermiston Foods of the well. He did not provide the GPS coordinates to DEQ.

March 3, 2010. DEQ approved Hermiston Foods' February 2010 Monitoring Well Location and Construction Plan.

March 5, 2010. DEQ issued a modification of Hermiston Foods' water pollution control facility permit to cover wastewater land application at the Chowning and Koester sites. During the comment period, DEQ received written comments from fifteen people. In general, many comments pertained to odors, groundwater contamination and the impacts odors and groundwater contamination may have on quality of life. Additional comments pertained to facility and groundwater monitoring, loss of property value, records retention, new pond design and piping, permit violations, over-spray and wind drift, ponding, and crops. DEQ paraphrased and combined similar comments, and replied to all comments received during the comment period.

March 16, 2010. Based on review of Hermiston Foods' 2009 Annual Report, DEQ issued a Warning Letter to the company for hydraulic loading limit exceedances at the old site. The violation was a Class II violation.

March 18, 2010. DEQ issued a permit action letter to remove Field S-1 from the wastewater land application program. Hermiston Foods proposed to remove the field after the permit modification established a 400-foot setback from all domestic wells.

June 2010. Hermiston Foods began processing peas and sugar snaps.

June 14, 2010. DEQ received an odor complaint from neighbors at the New Site.

June 14 to August 2, 2010. Hermiston Foods received 44 odor complaints.

June 23, 2010. DEQ inspected Hermiston Foods' new wastewater pond and irrigation fields. Although the permit required installation of drop tubes with low-pressure nozzles on all pivot irrigation equipment by April 30, 2010, an end gun was observed on the pivot in Field K-3. The aerator was running at the time of the inspection. A pea odor was evident in the area around the pond and sump. DEQ visited the area between Fields C-3 and C-5, and with wind from the east the staff could smell odor from the pond.

June 30, 2010. DEQ issued a Warning Letter to Hermiston Foods for wind drift of wastewater irrigation spray on an adjacent access road. The violation was a Class II violation. The Warning

Letter required the company to submit detailed procedures designed to prevent irrigation spray from impacting roads, irrigation ditches and adjacent properties. Until DEQ approves the procedures, the Warning Letter also established 100-foot setbacks from all access roads, public roadways and the irrigation ditch located on the northwest edge of Field K-1. And it prohibited irrigation of process wastewater at wind speeds that cause wind drift beyond property boundaries and required removal of end guns from all pivots.

July 6, 2010. In response to the Warning Letter, Hermiston Foods proposed to install drag tubes on the last 100 feet of each pivot on Fields K-2, K-3 and K-5 and then modify all other pivots in the same manner if the tubes mitigate wind drift. The company also proposed to remove all impact-type end guns except a single low mount impact-type end gun, which will be turned off an acceptable distance from the east and west boundaries on Field K-3.

July 12, 2010. DEQ inspected Hermiston Foods' land application fields. The wind was strong out of the west at the time and the company was only using two small pivots on the western edge of their fields. No wind drift was leaving their property. The pivots appeared to have been modified to observe the 100-foot setback.

July 14, 2010. Telephone conference between DEQ and Hermiston Foods to discuss complaints and odor issues.

July 15, 2010. Email to all participants summarizing telephone conference of July 14, including an outline of suggested elements for a written report from Hermiston Foods.

July 15, 2010. DEQ approved installation and operation of drag tubes on Field K-3 and agreed to allow drag tubes on other fields and lift the set back restriction and irrigation prohibition if Hermiston Foods can show that the drag tubes are successful at eliminating overspray and wind drift over a range of wind speeds and directions. DEQ did not approve end guns on any pivot. During the county land use hearings, neighbors raised concerns regarding over-spray and wind drift of irrigated wastewater and Hermiston Foods promised to mitigate their concerns with drop tubes. However, since then, DEQ found that drop tubes are not entirely effective and Hermiston Foods has consequently proposed to install drag tubes to further mitigate the problem. Therefore, DEQ believes that installation and operation of end guns is not approvable.

July 27, 2010. Email from Duane Smith, DEQ, to Bill Burich, Hermiston Foods, requesting confirmation of preparation of a written report as described in DEQ's July 15, 2010, email.

July 28, 2010. Bill Burich, Hermiston Foods, proposed to submit three reports over the next three weeks. The first report would address overspray and odor action plans. The second report would cover analyses of odor complaints, aeration equipment and the complaint process. The third report would be analyses of the land application hydraulic budget/water balance and general analyses of the facility compliance.

Aug. 2, 2010. DEQ received Hermiston Foods' first report regarding overspray and odor action plans. The company promised to lower drop tubes further, and evaluate changing nozzles and adjusting pressures within the next 30 to 60 days to further control wind drift and overspray. For odors at the pond, Hermiston Foods promised to add chemicals, install tighter screens, develop and analyze pH, dissolved oxygen and biochemical oxygen data, and evaluate planting trees and adding

additional aeration. For odors in the spray fields, the company promised to install drag tubes, lower drop tubes and increase droplet size.

August 5, 2010. DEQ conditionally approved Hermiston Foods' operations, maintenance and management plan and written request to install drag tubes on the outer 100 feet of other pivot equipment affected by the Warning Letter-imposed setback. The approval letter provided that, upon installation, the set-backs would be deemed removed and irrigation in the setback would be permitted. DEQ also noted that odor-monitoring responsibilities had been removed from a table in the plan and that the plan appeared to be silent on the issue of odor monitoring, despite the fact that the permit required odor-monitoring procedures to be included in the plan. DEQ required Hermiston Foods to propose odor-monitoring procedures for DEQ approval by Aug. 31, 2010.

Aug. 5, 2010. A neighbor reported odor and overspray onto the road by her house during her walk at 8 am. Hermiston Foods responded at 9:45 a.m., within 15 minutes of receiving the complaint. However, the road was dry. The company noted that although the sprinklers on the pivot end were set to shutoff as it reached its northern and western directions, the irrigator found a bent switch that might have caused it to malfunction that morning. The irrigator fixed the switch. Hermiston Foods also noted that installation of drag tubes on the last 100 feet of pivot would limit wind drift and overspray.

Aug. 5, 2010. DEQ received Hermiston Foods' second report regarding analyses of odor complaints, aeration equipment and the complaint process. The report showed that Hermiston Foods received 44 odor complaints from seven different neighbors between June 14 and Aug. 2, 2010. Thirty-seven complaints came from two neighbors. The remaining seven complaints came from five other sources with none of those having more than two complaints. Of the seven different neighbors, four are located within one-quarter mile of the northern boundary of the spray fields. Thirty-six percent of the complaints were between 6 p.m. and 9 p.m.; 57 percent were between 6 p.m. and midnight. Fifty-nine percent of the complaints occurred when wind speeds were low, one to four miles per hour. Regarding aeration equipment, Hermiston Foods concluded that more data is needed to provide definitive analyses. Hermiston Foods committed to three actions following the report: When possible, the Hermiston Foods personnel responding to the complaints will attempt to personally contact with the complainant. When possible, information will be logged showing the irrigation systems operating at the time when the complaints are received. Wind sock directions at the holding pond and Canal Road locations will be recorded at the time of the odor complaint response.

Aug. 9, 2010. A neighbor sent an email to DEQ with a copy to Umatilla County Commissioner Larry Givens. She indicated that the odors were causing stress and that Hermiston Foods representatives had told her that it is not their wastewater, rather it is the irrigation ditch, a wheat field and her own lawn that she smells. Carl Nadler, DEQ, called the neighbor and explained some of the things Hermiston Foods is doing to control odors and overspray and wind drift. He encouraged her to ask the company to accompany her to the pond, so she could compare the odor there with the odor at her house and see the odor controls they have in place. He then contacted Hermiston Foods and told them to expect the request.

Aug. 16, 2010. DEQ received Hermiston Foods' third report regarding analyses of the land application hydraulic budget/water balance and general analyses of the facility compliance. The report showed 0.3inch over-irrigation on one field and 0.01 inch and 0.02 inch on two other fields in May. Another field was over-irrigated 0.28 inches in July. The company noted that although four

fields were over-irrigated, the soil moisture monitoring shows that only the top foot of soil ever reached field capacity. All other fields were deficit irrigated.

Aug. 23, 2010. DEQ received Hermiston Foods' report regarding pH in the company's wastewater and the effectiveness of its pond aeration. Hermiston Foods concluded that dissolved oxygen profiles have shown good mixing and adequate dissolved oxygen levels at the most remote corners. However, the company admits a problem with the dissolved oxygen meter and DEQ will require the study to be redone with accurate equipment.

Sept. 1, 2010. DEQ received Hermiston Foods' report on nozzle pressure. At lower nozzle pressures, droplet sizes are larger and there is less risk of irrigation spray blowing off the site. According to the report, irrigation uniformity is compromised if system pressure drops below 40 psi. Therefore, Hermiston Foods informed DEQ that pump pressure is set at 42 psi and the pressure at the nozzles is about 40 psi. DEQ is still working with Hermiston Foods to determine if pressure reducers at each nozzle will be effective. The company also reported that it moved one pivot 100 feet away from an irrigation ditch and installed new, finer screens to remove more carrot peel at the processing plant.

Sept. 3, 2010. Hermiston Foods agreed to cease irrigation when wind speeds exceed 15 miles per hour.

Sept. 9, 2010. DEQ received a report from Hermiston Foods entitled "Setback Distances for Domestic Wells near the New Land Application Site." The WPCF Permit requires a 400-foot setback from all domestic wells, unless approved in writing by DEQ. The company submitted the report in support of its request that the setbacks be removed.

Sept. 22, 2010. DEQ responded in writing to Hermiston Foods reports regarding odors, over spray and the complaint system. DEQ posed 21 follow-up questions and requested a response by Oct. 8, 2010.

Sept. 28, 2010. DEQ met with neighbors at the OSU Experiment Station in Hermiston to hear complaints regarding Hermiston Foods. DEQ invited 35 neighbors and eight attended. Also present were Umatilla County Commissioner Larry Givens, Umatilla County Planning Director Tamra Mabbott, Umatilla County Code Enforcement Officer Gina Miller, Oregon Dept. of Agriculture (ODA) Deputy Director Lisa Hanson, and ODA Good Agricultural Practices Program Manager Jim Cramer. In general, most complaints pertained to odors, nitrates in groundwater and overspray and wind drift of wastewater.

Neighbors stated that odors made it hard to breathe, caused sore throats, is worse in mornings and evenings and affects their social lives and families. They said that Hermiston Foods' responders are slow to respond to complaints, are offensive, deny that there are odors, blame other things such as the complainant's yard, wet hay and the irrigation ditch for the odors and stand too close to them when they converse. One neighbor said she does not want the responders to knock on her door when they respond. Neighbors said that the wastewater irrigation fields smell bad even after the irrigation has been turned off. They said the pond aerator does not run continuously and the company does not blend sufficient fresh water with the wastewater to control odors. One person suggested that Hermiston Foods cover the wastewater pond. Another said that it was impossible for Hermiston Foods to blend water without discharging fresh water to the pond.

One neighbor is buying bottled water because they have measured nitrates in their well water. Neighbors did not understand why there was so much variability in groundwater nitrate concentrations over the area. Commissioner Givens encouraged the neighbors to review the construction of their wells and to check their well logs to determine if their wells were shallow or basalt wells.

Neighbors expressed concerns about what is in Hermiston Foods wastewater and whether it could damage crops on adjacent fields, particularly in the case of one neighbor who raises produce in the Good Agricultural Processes program. Jim Cramer, ODA, explained that USDA created the GAP program for growers that wanted to produce certified high quality crops. The program is voluntary and ODA audits crops in the GAP program in Oregon. In order to meet certification criteria, participating growers must have real-time evidence of everything that goes on the crops. That means that this neighbor must have real-time evidence that chemical and bacterial concentrations in Hermiston Foods wastewater meet the certification criteria if the wastewater is over-sprayed on his crops. Absent that information, his crops would not meet GAP program requirements. The neighbor is concerned about bacteria and pesticide in Hermiston Foods wastewater. He said Hermiston Foods should be able to show the neighbors what is in the wastewater, such as pesticides and cleaning products. There was concern that DEQ is not enforcing on overspray andwind drift and that the 15 miles per hour wind speed shut-off was not conservative enough.

Planning Director Mabbott suggested that the county, state and Hermiston Foods work together on a creative solution such as a land trade to enable land application of wastewater elsewhere far away or grant support for construction of wastewater treatment facilities so the wastewater does not stink. In addition, Planning Director Mabbott suggested a third party check of crop-specific evapotranspiration rates.

Sept. 29, 2010. Linda Hayes-Gorman and Carl Nadler, DEQ, met with a neighbor at her home at 7:30 am to “smell what she smells in the morning.” On arrival, there was a noticeable odor outside and inside the home. After about 20 minutes, a breeze picked-up outside and the outside odor decreased. However, the odor inside the home remained.

Sept. 29, 2010. Linda Hayes-Gorman and Carl Nadler, DEQ, met with Hermiston Foods staff and toured the wastewater facility. According to Hermiston Foods, the pond aerator operates continuously. In addition, the company showed that, based on complaint records, complaint response time is less than 30 minutes, typically seven to 10 minutes.

During the tour, drag tubes on Field K-2 were turned off, although the spray nozzles were on. When the drag tubes were on, some did not work. Further investigation revealed that the orifices were plugged with carrot pieces. After removing the carrots, the water that came out had a strong offensive odor. Hermiston Foods explained that carrots got through the system due to a failure in the solids elevator conveyor at the plant. DEQ advised the company that it expected the company to maintain its equipment in order to comply with its permit.

In order to minimize odors, DEQ discussed the possibility of flushing the irrigation lines with fresh water prior to each shut down cycle. Hermiston Foods pointed out that it could lead to greater inaccuracy in hydraulic and nutrient calculations. DEQ will continue to explore this possibility with Hermiston Foods.

At the time of the visit, Hermiston Foods was irrigating with 100 percent effluent. The company explained that if it blended fresh water with wastewater to irrigate, then more wastewater would need to be stored in the pond. The company also explained the blending equipment and it was clear that fresh water could be blended without mixing in the pond.

Regarding crop-specific evapotranspiration rates, Hermiston Foods stated that the rates provided by AgriMet did not fit their wheat and corn crops because Hermiston Foods planted their crops after the assumed crop start date that AgriMet uses. DEQ will continue discussions with the company regarding appropriate crop specific evapotranspiration rates.

Oct. 3, 2010. A neighbor reported that wind speeds were between 16 and 22 miles per hour yet Hermiston Foods continued to irrigate. She said that she did not observe any overspray off Hermiston Foods' property. DEQ contacted Roy Stephens, Hermiston Foods, who said that it was his understanding that the 15 miles per hour shut-off was only for the duration of a wind storm in early September and that it was not extended.

Oct. 4, 2010. DEQ requested Hermiston Foods to agree to extend the 15 miles per hour shut-off agreement.

Oct. 6, 2010. Hermiston Foods declined DEQ's request to extend the 15 miles per hour shut-off agreement. The company promised to turn off any individual pivot or system that would risk overspray. They said they did not want to be in a situation of shutting off all systems and diverting the entire wastewater flow to the pond, where odors could develop, when wastewater could be irrigated safely without overspray issues. The company promised to complete an assessment of wind speed and irrigation aerosol drift distance.

Oct. 8, 2010. DEQ received a letter from IRZ Consulting, Hermiston Foods' consultant,) opining that DEQ's hydraulic loading restrictions forced Hermiston Foods to store wastewater in the pond, causing odor complaints and stressing the crops. In order to prevent nitrate leaching below the root zone and adverse impact to groundwater, DEQ limits hydraulic loading from all sources including precipitation and supplemental water to the crop-specific evapotranspiration rate on a monthly basis.

In the letter, IRZ explained that, on a daily basis, the total month-to-date net irrigation amount is subtracted from the total month-to-date hydraulic loading rate to determine the amount of irrigation that can be applied to each spray field. IRZ reported that Hermiston Foods has not irrigated up to the permitted hydraulic loading rate because Hermiston Foods does not irrigate until the evapotranspiration has occurred, farming operations on the fields prevent irrigation and Hermiston Foods enacted a plan not to irrigate when wind speed is high. IRZ stated that limiting irrigation until evapotranspiration occurs causes problems at the start of each month. Tthe irrigation system is not capable of catching up to the evapotranspiration limit at the end of each month. IRZ says the result is that wastewater is stored in the pond and that leads to odor complaints. To note, DEQ limits hydraulic loading to the evapotranspiration rate on a monthly basis. It does not require Hermiston Foods to match evapotranspiration on a daily basis within each month. In order to be able to irrigate more water, IRZ proposed that DEQ allow Hermiston Foods to use the checkbook method of irrigation and limit hydraulic loading to the evapotranspiration rate on an annual basis.

Oct. 8, 2010. DEQ received Hermiston Foods' response to its September 22 letter. In its response, Hermiston Foods proposed to submit its updated odor complaint analyses by October 18. The company reported that all sprinkler drop tubes had been lowered to reflect crop height, that the addition of live bacteria and nitrate compounds to the wastewater system did not result in fewer odor complaints, that the dissolved oxygen meter is properly calibrated, that dissolved oxygen concentrations are never below 0.5 mg/l in the system, that the company will plant trees around the pond in spring 2011, that the evaluation of the need for an additional aerator is still ongoing, that the use of vanilla and mint masking agents did not result in fewer odor complaints, and that reducing the line pressure did not result in larger droplets and less misting.

Hermiston Foods reported that during the second alfalfa harvest, too many acres were cut at one time and it took too long for the crop to dry, be baled and removed. The company promised that future hay harvests will be arranged to assure that irrigation can continue on some parcels and that all alfalfa fields are not taken out of production simultaneously to prevent overloading the pond.

The company stated that it would add drag tubes to the outer sections of C-1, C-3, C-5, K4A and K-5. K-2, K-3 and C-2 are already equipped with drag tubes on the outer section. Hermiston Foods reported that data do not support expansion of drag tubes on the full length of pivots for odor control. They said the effect from drag tubes on odor reduction efforts is difficult to evaluate. Moreover, they noted that drag tubes water the crops imperfectly and do not distribute the water adequately to achieve proper crop germination. The permit requires wastewater to be distributed as evenly as practicable within each field in order to prevent overloading and impact to groundwater. DEQ staff is cautiously concerned about the use of drag tubes compromising our efforts to prevent groundwater impacts.

Hermiston Foods stated that it is making improvement in the accuracy of its flow measuring. Rather than metering the amount of water and wastewater to each field, Hermiston Foods multiplies the run time of each pivot by the flow rate for that pivot, sums the volume irrigated by each pivot for the month and multiplies it by a flow correction factor to equal the total flow measured at the irrigation sump. Between April and July, the flow correction factor varied between 0.87 and 1.27. In its October 8 letter, the company said that the correction factor for August would be 1.02.

Hermiston Foods stated that the pond aerator had been on continuously since the start of taking dissolved oxygen measurements. Dissolved oxygen measurements were started on July 21. According to data submitted by the company on October 29, the aerator was off for 14 days during that period.

The company explained its method of doing a dissolved oxygen profile of the pond only at the shallow end of the pond by saying that the area at the deep end is rather limited. The outlet from the pond to irrigation is at the bottom of the deep end and DEQ is concerned about the ability of the aerator to affect the water in the deep end. DEQ will continue to work with Hermiston Foods to get a dissolved oxygen profile of the deep end.

Oct. 14, 2010. DEQ received a letter from IRZ Consulting that outlined the checkbook method of irrigation that was proposed in IRZ's October 8 letter.

Oct. 14, 2010. DEQ had a telephone conference with Hermiston Foods. Linda Hayes-Gorman, Cheryll Hutchens-Woods, Duane Smith and Carl Nadler represented DEQ and Bill Burich, Mark Steele, Roy Stephens and Mark Croeni, along with Bill Hutchison from Roberts Kaplan and Gina Gray from IRZ Consulting, represented Hermiston Foods. During the discussion, IRZ Consulting presented the checkbook method and requested that DEQ approve it and extend the period for evapotranspiration compliance from a monthly basis to an annual basis. DEQ requested Hermiston Foods' soil moisture monitoring results and asked the company to submit the request in writing for DEQ review.

Oct. 18, 2010. Hermiston Foods submitted its updated analyses of odor complaints. The report showed that Hermiston Foods received 116 odor complaints from 16 different neighbors between the time vegetable processing started in 2010 and October 6, 2010. Eighty-nine complaints came from two neighbors. Not including those who refused to give a name, the remaining 23 complaints came from 13 other sources with none of those having more than three complaints. Of the 16 different neighbors, four are located within one quarter-mile of the northern boundary of the spray fields. Forty-three percent of the complaints were between 6 and 9 p.m.; 61 percent were between 6 p.m. and midnight. Seventy-seven percent of the complaints occurred when wind speeds were low, one to four miles per hour. Sixty-eight percent of the complaints occurred when wind was out of the south, southeast and southwest blowing toward neighbors. However, 28 percent of the complaints occurred when the wind was out of the west, northwest and north blowing away from neighbors. The number of complaints per day increased as the percent of wastewater being irrigated increased and as the amount of wastewater being stored in the pond increased.

Oct. 19, 2010. DEQ received Hermiston Foods' revised operations, maintenance and management plan, which incorporated the checkbook method and proposed that Hermiston Foods meet the evapotranspiration rate on an annual basis.

Oct. 29, 2010. DEQ received Hermiston Foods' soil moisture monitoring results.

Nov. 1, 2010. DEQ conditionally approved Hermiston Foods' revised operations, maintenance and management plan incorporating the checkbook method. However, rather than modifying the water pollution control facility permit, which prohibits hydraulic loading in excess of the evapotranspiration rate on a monthly basis, DEQ agreed to allow Hermiston Foods to demonstrate, during a trial period over the next year, that environmental impacts to groundwater can be avoided with the compliance period extended to two months at a time. During the trial period, Hermiston Foods must continue to report evapotranspiration and hydraulic loading on a monthly basis. DEQ prefers not to extend the compliance period to a year due to the risk of over-irrigation and leaching in the late season when evapotranspiration is low. DEQ limited irrigation line pressure to 42 psi, prohibited irrigation at wind speeds greater than 30 miles per hour and during any condition that may cause overspray or wind drift to occur. That prohibition had been included in the previously approved operations, maintenance and management plan and was removed from the recently revised plan. DEQ also required recording wind direction at two locations when investigating complaints..

Nov. 2, 2010. Hermiston Foods submitted a written request to reconsider allowing hydraulic loading up to the evapotranspiration rate on an annual basis, to require a wind direction reading from only one wind sock during complaint investigation and to allow Hermiston Foods' discretion to irrigate at any wind speed.

Nov. 4, 2010. DEQ held a meeting at its Hermiston office to talk about creative ways of addressing the odors issue. At the meeting were Lisa Hanson (ODA Deputy Director), Linda Hayes-Gorman (DEQ Regional Administrator), Scott Fairley (Governor's Economic Revitalization Team), Tamra Mabbott (Umatilla County Planning Director), Gina Gray (IRZ Consulting), Mark Croeni (Hermiston Foods), Roy Stephen (Hermiston Foods), Bill Burich (Hermiston Foods) and Bill Hutchison (Roberts Kaplan, attorney for Hermiston Foods). The company presented background and historical information on their business in Hermiston. Discussions covered many topics including land use, measures taken to reduce odors and overspray, the checkbook method for irrigation, nitrate concerns in the Lower Umatilla Groundwater Management Area, and measures already taken and planned to address odors.

Nov. 4, 2010. DEQ held a second listening session at the OSU Experiment Station in Hermiston, and invited 35 neighbors, eight of whom attended. DEQ also invited Larry Givens (Umatilla County Commissioner), Tamra Mabbott (Umatilla County Planning Director), Gina Miller (Umatilla County Code Enforcement), Melissa Newman (Umatilla County Public Health), Lisa Hanson (ODA Deputy Director), Dan Cain (DHS Public Health), Rick Hill and Phil Richerson (DEQ Hydrogeologists), six representatives from Hermiston Foods (Bill Burich, Mark Steele, Roy Stephen, Craig Williams, Cyd Bothum and Mark Sather) and Gina Gray (Hermiston Foods' consultant from IRZ Consulting).

During the session, Hermiston Foods presented an update of recent and planned improvements to control odors. The company said the ideal situation would be to irrigate wastewater as quickly as possible, but that they had to divert wastewater to the pond because of permit restrictions. They reported that there were two to three times more odor complaints when wastewater was stored in the pond in the summer. Hermiston Foods has pointed to the hydraulic loading limit, which limits hydraulic loading from all sources to the evapotranspiration rate on a monthly basis, as the reason for storing wastewater instead of land applying it. However, analysis of irrigation data showed that Hermiston Foods had actually failed to use all available evapotranspiration. Moreover, Hermiston Foods proposed to use the unused evapotranspiration from last summer to justify irrigation in November when evapotranspiration is lower and the risk of leaching during winter storm events is higher. Hermiston Foods said that they planned to install automation and telemetry on K-3, which would allow for quicker response to odor complaints and changing atmospheric conditions.

Dan Cain from DHS explained that odors may cause subjective, objective and emotional symptoms and that, unless an odor is toxic, symptoms end when exposure to the odor ends. He said there are many variations in reactions to odors and that reactions are affected by individual stress and sensitivity. Women are generally more affected than men are. A neighbor stated that it is also a quality of life issue, that Hermiston Foods' odors produce stress and social disruption. A neighbor asked if the effects of bacteria and mold in wastewater aerosols were known and Mr. Cain said that, according to Public Health Division's toxicologist, there are no known problems with bacteria in aerosols. He said that mold spores are ubiquitous and would be present even if Hermiston Foods wastewater were not there. Mr. Cain said he would do further literature search on bio-aerosol assays.

Hermiston Foods reviewed its analyses of odor complaint records. They reported that most complaints occurred in the evening and that 77 percent occurred in still winds. They said there were fewer complaints than expected when the wind was blowing toward neighbors out of the

southwest, south and southeast. They received 28 percent of the complaints when the wind was blowing away from neighbors out of the west, northwest and north. A neighbor noted that southwest winds would be carrying odors into uninhabited areas and Hermiston Foods said the company would review the data again. Hermiston Foods apologized to the neighbors for the odors and offered to change irrigation scheduling for special events if neighbors called in advance. A neighbor asked if Hermiston Foods could cover the pond to prevent odors from escaping and Hermiston Foods noted that covering the pond might counteract aeration efforts. Lisa Hanson from ODA suggested contacting Troy Downing, an expert on covering dairy ponds at ODA.

A neighbor asked how they can be sure Hermiston Foods will not cause nitrates in groundwater to increase. Rick Hill, DEQ, explained the groundwater monitoring program at Hermiston Foods site and he and Phil Richerson, DEQ, answered questions pertaining to nitrate contamination in groundwater and the Groundwater Management Area. Rick Hill noted that groundwater nitrate concentrations ranged from 1.8 to 70 mg/L in the area. He identified Hermiston Foods' monitoring well locations on a poster-size site map and explained groundwater flow directions. Hill stated that DEQ did not allow Hermiston Foods to begin irrigating until the monitoring well network was installed. Duane Smith, DEQ, explained that the purpose of the permit is to protect groundwater by establishing limits on irrigation. Umatilla County Commission Larry Givens asked if it was possible for deep basalt wells to contaminate the alluvial aquifer and Hill explained that it was unlikely for the basalt wells to contribute anything but cleaner water. Hill explained that it would take several years of monitoring to establish groundwater quality trends. A neighbor suggested monthly groundwater monitoring during the land application and growing season and Hill explained that monthly water levels may be useful in order to understand fluctuations in groundwater flow direction; but, that monthly groundwater quality monitoring would not useful because the groundwater is not moving fast enough to see a change in groundwater quality from month to month.

A neighbor asked whether Hermiston Foods could be held to a statement it made in a land use hearing regarding blending wastewater with fresh water in a 25/75 percent ratio. According to Umatilla County Planning Director Tamra Mabbot, the statement could not be enforced because it was not made a condition of land use approval and it is not part of the findings to show compliance with the applicable land use standard.

A neighbor noted that Hermiston Foods' odor complaint responders are rude, deny that odors exist and attribute odors to other sources. Hermiston Foods replied that their responders are not coached and are instructed to truthfully characterize odors. A neighbor noted that dealing with the responders is stressful and that some neighbors refuse to deal with them. Hermiston Foods countered that the company has and will honor requests to not send responders to visit complainants that do not want to be visited.

A neighbor asked to see data on health effects of spray and odor. Another asked that the neighbors be given contact information for all government representatives at the listening session.

Nov. 5, 2010. Hermiston Foods requested permission to exceed the evapotranspiration rate on selected fields because the company projects wastewater flows until plant closure to exceed the remaining capacity in the pond. The company estimates that it will need to irrigate about five million gallons in November. In trying to work with the company and ensure groundwater

protection, DEQ requested analyses of remaining soil storage capacity, along with projected precipitation and evapotranspiration during the winter months.

Nov. 9, 2010. Linda Hayes-Gorman explained to Bill Burich at Hermiston Foods that, for the protection of groundwater, DEQ would not be able to allow the company to exceed the evapotranspiration rate and violate its permit in order to dispose of the five million gallons.

Nov. 17, 2010. Hermiston Foods ended its irrigation season.

Nov. 18, 2010. The last odor complaint of the season was received.

Nov. 18, 2010. Neighbors complained that they could not reach Hermiston Foods after hours. Roy Stephens explained that the plant was done processing for the year and therefore not running 24/7 anymore. He said that calls that come in after normal business hours would be recorded and that the company would respond to them when they are heard.

Nov. 22, 2010. Bill Hutchison, on behalf of Hermiston Foods, proposed that Hermiston Foods meet with Hayes-Gorman and other DEQ staff during the second week of January 2011 to discuss water pollution control facility permit provisions, the current operations, monitoring and management plan and Hermiston Foods' optimization concepts.

Nov. 23, 2010. Lisa Hanson, ODA, recommended that DEQ contact Don Hornick at the OSU Hermiston Research Station to assist in evaluating the checkbook method.

Nov. 23, 2010. DEQ received a follow-up email from Dan Cain, DHS Public Health, regarding his literature search on bio-aerosol assays. He reported that there is not much to be found in the literature. However, he reiterated that he did not see much risk of pathogens getting aerosolized from the pond or the aerator. He said that he spoke with Troy Downing of OSU Extension's dairy farm in Tillamook, who agreed with him. While he does not have any actual data to back this up, others at the Public Health Division believe the same. Public Health Division staff feels that the true pathogenic risk of Hermiston Foods' wastewater pond is via direct contact with the water. Downing and Cain also agreed that reducing the amount of overspray, by using drag tubes and larger aerosol sizes, should limit the amount of pathogens in the air. Cain does not believe that airborne testing would be overly useful in this case. His opinion is that nearby residents would not be very satisfied with a detailed chemical/biological report if the odor was still present.

Nov. 30, 2010. Hayes-Gorman's planned discussion with the EQC at the December 2010 meeting was postponed until the Feb. 16-18 EQC meeting.

Dec. 2, 2010. Hermiston Foods requested copies of wastewater permits for other food processors in the area.

Dec. 9, 2010. DEQ received an inquiry from a paralegal from the law office of Justin J. Burns regarding a copy of the Hermiston Foods file. DEQ forwarded the Public Records Request Form to the law office and suggested they may want to review the file at DEQ before copying it in its entirety.

Dec. 9, 2010. DEQ initiated an internal review of the Hermiston Foods project.

Dec. 13, 2010. DEQ responded with comments to Hermiston Foods' report on reducing setback distances from domestic wells. DEQ believes the company used incorrect information in its calculations and requested that it reevaluate its findings.

Dec. 13, 2010. Lisa Hanson, ODA, requested a list of crops on which Hermiston Foods' wastewater could be applied.

Dec. 15, 2010. DEQ received two pond dissolved oxygen profiles from Hermiston Foods that were developed on November 19 and December 2, 2010. Based on the data, the company concluded that the single aerator is adequate and that mixing is good. However, the company noted that the aerator cannot handle the plant's peak day biochemical oxygen demand load, which occurs at the same time that irrigation requirements exceed the process water flow rate.

Jan. 7, 2011. The meeting between Hermiston Foods and DEQ that was scheduled for the second week of January 2011 was postponed pending completion of a DEQ internal review of the Hermiston Foods project.

Jan. 10, 2011. Hermiston Foods notified DEQ that it plans to construct an emergency surge basin near the plant to hold wastewater during pipeline repairs. DEQ requested plans and specifications be submitted for review and approval.

RESPONSES TO QUESTIONS RAISED AT THE AUG. 19, 2010, EQC MEETING

1. Does parking lot storm water and boiler blowdown enter the wastewater system and should that be split to send to the City's wastewater treatment plant to deal with heavy metals?
Stormwater from employee parking and product receiving areas, boiler blowdown and condenser water are discharged to the industrial wastewater system. Based on knowledge of process, DEQ does not expect those waste streams to contain significant concentrations of heavy metals or oil and grease. For the most part, the company's wastewater is derived from processing fresh vegetables. Stormwater from employee parking is actually exempt from federal permitting requirements and may be discharged to waters of the state without a permit.

How are DEQ and Hermiston Foods handling the pesticides going to the lagoon and sprayfields?
The Oregon Department of Agriculture regulates pesticide use and only approved chemicals can be put on crops. When Hermiston Foods receives a crop, they also receive a pesticide sheet from the grower that shows all of the chemicals that have been applied to the crop and the dates and times of application. Growers are required to follow label directions, which limit the amount of pesticide applied and time between application and harvest applications prior to harvest. Hermiston Foods also has a staff that are responsible for crop quality. They track the crops from seed selection through to harvest. Their approval is required for every chemical application, as well as the dwell times between application and harvest.

Why was Hermiston Foods not required to select an alternative to land application?
It is not the role of the DEQ or the county to prescribe what process is best for Hermiston Foods, only that whatever process they choose complies with applicable, adopted laws.

What is DEQ doing about overspray and wind drift?

The permit prohibits irrigation spray on roads and irrigation ditches. It also prohibits irrigation spray, including wind drift, beyond those lands that have been approved by Umatilla County for land application of Hermiston Foods' wastewater. On June 30, 2010, DEQ issued a Warning Letter in response to an overspray complaint from a neighbor. The Warning Letter required Hermiston Foods to observe a 100-foot setback from all access roads, public roadways and an irrigation ditch located on the northwest edge of field K-1 until DEQ approves procedures developed by Hermiston Foods to prevent overspray. Since the Warning Letter was issued, DEQ has received only one complaint of overspray. Hermiston Foods responded by sending a person into the field but they did not observe any overspray.

Why has DEQ not pulled the permit yet?
DEQ's enforcement rules are codified at Oregon Administrative Rule Chapter 340, Division 12. The rules require DEQ to use increasing levels of enforcement action and to base penalties on the class and magnitude of violation, aggravating and mitigating factors, and the economic benefit realized. To date, there have been no violations that would justify pulling the permit.

Terry Rowan: Mr. Rowan called Carl Nadler in June or July after Hermiston Foods began irrigating on the New Site. Mr. Rowan represented that he was acting in his official capacity in the Sheriff's office to complain about odors from Hermiston Foods. Mr. Rowan was complaining in general about the odors. Mr. Nadler explained the permit requirements and Hermiston Foods odor management procedures. Mr. Rowan said that he could also do an investigation through the Sheriff's office.

Why does DEQ not require setbacks?
In order to establish setbacks or buffer zones for wastewater irrigation, DEQ must identify a human health hazard or an environmental impact. For instance, recycled municipal wastewater that is irrigated may contain human pathogens, depending on the level of disinfection. When permitting irrigation of recycled municipal water, DEQ establishes appropriate setbacks to prevent human contact with the pathogens. In Hermiston Foods' case, the wastewater is not known to contain human pathogens or any other contaminant, other than nitrate, in concentrations that may be harmful to humans. Because nitrate is harmful when consumed at concentrations greater than 10 mg/l, DEQ established a 400 foot setback from down-gradient domestic wells. Four hundred feet is the distance groundwater at the site is expected to travel in two years.

The New Site (Chowning & Koester) is a poorly picked site.
From an environmental perspective, the New Site is suitable for land application of food processor wastewater as long as groundwater is protected and nuisance conditions are not created. The permit includes provisions to protect groundwater and prohibit nuisance conditions, as well as prohibiting run-off and overspray. Given the proximity to residential neighbors and the odor generated from wastewater irrigation, the New Site may not be suitable from a land use perspective. However, DEQ is not a land use authority and can only include conditions in permits that comport with the scope of its authority as it pertains to human health and the environment.

There is a concern about food safety with respect to Hermiston Foods' wastewater.
Hermiston Foods wastewater contains nitrogen compounds. At concentrations greater than 10 mg/l, orally ingested nitrate can be hazardous to infants. On the other hand, nitrogen is a plant nutrient and land application on food crops is a feasible way to reuse the wastewater, so long as

is done in a manner that is protective of human health and the environment. DEQ knows of no human health risk from consuming crops fertilized with nitrate fertilizer or from consuming livestock that consumed crops fertilized with nitrate fertilizer. In general, DEQ allows the permittee to select the crops, but then limits the amount of nitrogen that can be applied to the agronomic rate required to grow the crop. In that way, the crops will use nitrogen that is applied and groundwater is protected.

Why does DEQ rely on Hermiston Foods for self monitoring?
DEQ relies on self-monitoring at all permitted facilities because of the costs involved with sampling and analysis. It should be noted that failure to monitor is a Class I violation of the DEQ's enforcement rules and submittal of false reports is a crime.

It appears that something in the wastewater killed the poplar trees.
Hermiston Foods planted hybrid poplars at Windblown Ranch several years ago. During the Jan. 8, 2009 inspection, the company informed DEQ that an insect killed some of the clones. Hermiston Foods' wastewater is not expected to have caused the mortality because it has been used successfully to grow crops for twenty years. When DEQ learned the trees were no longer viable, it prohibited the company from land applying wastewater on them. As a result, the rest of them died.

Phil Richerson says that Hermiston Foods is obviously affecting groundwater.
Phil Richerson, DEQ, performed trend analyses on groundwater conditions at the Windblown Ranch site. He concluded that facility operations affected groundwater quality there because down-gradient nitrate concentrations exceeded up-gradient nitrate concentrations. Richerson also concluded that water quality is beginning to improve beneath the Windblown Ranch site because down-gradient trends have recently began decreasing or are less steeply increasing. There is not enough data at the New Site to make conclusions regarding groundwater nitrate trends.

Why would DEQ write a Warning Letter on transfer of the permit to the New Site?
The Warning Letter was not issued on the transfer of the permit. To facilitate the move to the New Site, DEQ modified the permit specifically to address conditions at the New Site. Shortly after DEQ issued the permit modification, and after reviewing Hermiston Foods 2009 Annual Report, DEQ issued a Warning Letter to the company for a hydraulic loading rate exceedance at the Windblown Ranch site.

NEXT STEPS

Hermiston Foods will:

Reduce wind drift and overspray

- Complete an assessment of wind speed and irrigation aerosol drift distance
- Add drag tubes to the outer sections of C-1, C-3, C-5, K4A and K-5

Reduce odors at the pond

- Continue to develop pH, dissolved oxygen and biochemical oxygen demand data from the wastewater system
- Plant trees around the pond in the spring 2011
- Continue to evaluate the need for an additional aerator in the pond

- Arrange future hay harvests to assure that irrigation can continue on some parcels and that all alfalfa fields are not taken out of production simultaneously to prevent overloading the pond

Reduce odors at irrigation systems

- Review complaint database to confirm the number of complaints when wind is out of the southwest
- Change irrigation scheduling for special events if neighbors call in advance
- Honor complainants' requests to not send responders to visit complainants that do not want to be visited

Other

- Continue to improve the accuracy of flow measurements to the spray fields

DEQ will:

- Require that a dissolved oxygen profile in the pond be repeated and daily measurements be continued with a properly calibrated meter
- Based on dissolved oxygen monitoring results, discuss with Hermiston Foods the feasibility of:
    - Additional aeration or construction of a secondary treatment facility to reduce biochemical oxygen demand
    - Modifying the outlet pipe from the pond to allow for discharge from the pond at multiple levels
- Contact Troy Downing, an expert on covering dairy ponds at ODA, to discuss the feasibility of covering the pond
- Provide results of DHS literature search to neighbors
- Provide neighbors with contact information for all government representatives at the listening session

DHS will:

- Perform a literature search on bio-aerosol assays

ODA will:

- Provide technical contacts for agricultural issues

Summary
DEQ met with neighbors and representatives of other government agencies at the OSU Experiment Station in Hermiston to hear their complaints regarding Hermiston Foods. In general, most complaints pertained to odors, nitrates in groundwater and overspray/wind drift of wastewater.

State of Oregon
Department of Environmental Quality

Eastern Region
Water Quality Program
400 E. Scenic Dr.
The Dalles, OR 97058
Phone: (541) 298-7255
(800) 452-4011
Fax: (541) 298-7330
Contact: Carl Nadler
www.oregon.gov/DEQ

DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

Attendance
Invitations were made to 35 neighbors. Eight neighbors attended.

Also present were:

- Larry Givens, Umatilla County Commissioner
- Tamra Mabbott, Umatilla County Planning Director
- Gina Miller, Umatilla County Code Enforcement Officer
- Lisa Hanson, Deputy Director, Oregon Department of Agriculture (ODA)
- Jim Cramer, Good Agricultural Practices Program Manager, ODA
- Linda Hayes-Gorman, DEQ Eastern Region Administrator
- Cheryll Hutchens-Woods, DEQ Water Quality Manager
- Duane Smith, Waste Water DEQ Permitting Manager
- Carl Nadler, Waste Water DEQ Permit Writer
- William Knight DEQ Office of Communications and Outreach

Concerns

Odor Problems
Neighbors stated that odors from the facility:

- made it hard to breathe
- caused sore throats
- is worse in mornings and evenings
- affects their social lives and families.

Company Response Issues
Neighbors said that Hermiston Foods' responders are:

- slow to respond to complaints
- are offensive
- deny that there are odors
- blame other things such as the complainant's yard, wet hay and the irrigation ditch for the odors
- stand too close to them when they converse

One neighbor said she does not want the responders to knock on her door when they respond.

Groundwater concerns
Neighbors voiced concerns that wastewater leached nitrates into groundwater. One neighbor is buying bottled water because they have measured nitrates in their well water. Neighbors inquired as to why there was so much variability in groundwater nitrate concentrations over the area. DEQ staff provided an overview of ground water contamination and its variability in the Lower Umatilla Basin Ground Water Management Area. DEQ offered to bring back a specialist to address this issue for a next listening session if it was desired.

Commissioner Givens encouraged the neighbors to review the construction of their wells and to check their well logs to determine whether their wells were shallow or basalt wells. This was suggested so that people are familiar with their well's construction.

Potential overspray

There was concern about what is in Hermiston Foods wastewater and whether it could damage crops on adjacent fields through overspray and/or wind drift.

Don Walchli, a neighbor, raises produce in the GAP program. Jim Cramer, from ODA, explained that the US Dept. of Agriculture created the GAP program for growers that wanted to produce certified high-quality crops. The program is voluntary and ODA audits crops in the GAP program in Oregon. In order to meet certification criteria, participating growers must have real-time evidence of everything that goes on the crops. That means that Mr. Walchli must have real-time evidence that chemical and bacterial concentrations in Hermiston Foods wastewater meet the certification criteria if the wastewater is over-sprayed on Mr. Walchli's crops. Absent that information, Mr. Walchli's crops would not meet GAP program requirements.

Mr. Walchli is concerned about bacteria and pesticide in Hermiston Foods wastewater. He said Hermiston Foods should be able to show the neighbors what is in the wastewater, such as pesticides and cleaning products. There was concern that DEQ is not enforcing on overspray/wind drift and that the 15 mph wind speed shut-off was not conservative enough.

Other comments and suggestions

Neighbors said that the wastewater irrigation fields smell bad even after the irrigation has been turned off. They said the pond aerator does not run continuously and the company does not blend sufficient fresh water with the wastewater to control odors.

In general, the level of trust is down because of the recent history.

Next steps

Planning Director Mabbott suggested that the County, State and Hermiston Foods work together on a creative solution such as a land trade to enable land application of wastewater elsewhere far away or grant support for construction of wastewater treatment facilities so the wastewater does not stink. In addition, Planning Director Mabbott suggested a third party check of crop-specific ET rates.

The meeting produced a list of actions that all involved parties could take to help resolve the situation:

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Proposed action items

Action	Owner	Status
Keep aerator on	HF	Aerators are always on unless pond level drops too low
Use consistent 50/50 wastewater/freshwater mix	HF	Water mix varies w/timing of fresh water availability, processing volumes, weather and irrigation needs
Test pond and prove proper aeration in accordance with permit	HF	Testing daily Dissolved Oxygen (DO) content
Reduce solids in waste water	HF	300% smaller screens installed at plant and pond. Using 10/1000" opening
Identify supplemental water source	DEQ, HF	Ditch water and groundwater from wells K-3, C-1 used for blending with wastewater
Characterize contents of wastewater	DEQ, HF	Performed twice monthly for nutrient content
Look into whether covering the ponds is a possibility	DEQ, HF	Possible, but not proposed
Examine creative alternatives such as: GERT, grants, land trade and/or better water treatment	DEQ, Umatilla County	Meeting held with HF, state and local agencies, and representative from Governor's office to discuss options
Look into third party check for ET rates	DEQ, Umatilla County	Using IRZ and Agrimet
Review reports of data/records of land application	DEQ	Reviewed soil moisture
Verify mixing system	DEQ	Done; mixing system in place
Look into reducing 15mph wind cutoff	HF	Assessment in progress for adaptive management model that will shut down areas affected by winds, not whole system
Obtain historic data on nitrate levels in groundwater	Citizens	
Obtain well logs; check wells for construction, depth and water quality history	Citizens	

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Questions and answers from Sept. 28, 2010, listening session

1. Hermiston Foods promised to aerate the wastewater pond to prevent odors; however, we do not hear the aerator running.

Hermiston Foods' records indicate that the aerator was off for 14 days between July 20 and Oct. 24, 2010. Based on company records, Hermiston Foods did not run the aerator on:

- July 21,
- July 25 to July 30,
- Aug. 28 to Sept. 3.

Aerator operational status was not reported on July 20 and July31.

2. Hermiston Foods promised to blend fresh water with wastewater at a rate of 10:1, why are they not doing that?

Hermiston Foods proposed an annual ratio of 80% fresh water, 20% wastewater for irrigation. However, irrigation needs and wastewater flow vary daily. On any given day, the ratio of fresh water to wastewater may be different than the annual loading ratio.

3. Why do nitrate concentrations vary between wells in the area?

Nitrate concentrations in area ground water vary for a number of reasons. One of the primary factors is pollution migrating into the water table from the surface. This commonly results in higher concentrations at the surface of the water table. As groundwater moves, small amounts of contaminants are pulled into deeper portions of the aquifer. Pumping wells located near contamination also tend to pull contaminants deeper into the aquifer. These factors result in uneven mixing in the aquifer. Because of the uneven mixing, neighboring wells frequently have different concentrations. This is especially true for wells screened at different depths.

4. What are the piles east of the wastewater pond?

The piles east of the pond are soil left over from construction of the wastewater pond.

5. Which water supply wells are used for blending?

Groundwater from Wells K-3 and C-1, along with Stanfield Ditch water, is used for blending with wastewater.

6. Can the wastewater pond be covered?

Although it is possible to cover the pond, Hermiston Foods has not proposed to do so. Covering the pond would not eliminate odors from irrigation

Odors from the wastewater pond should be controlled with adequate aeration.

7. How can Hermiston Foods blend fresh water with wastewater without the two streams going through the pond?

Wastewater and fresh water can be mixed in the irrigation sump before irrigation.

8. Are there pesticides and cleaning products in Hermiston Foods' wastewater? If so, how much?

According to Hermiston Foods, the company does not add any pesticides to the process water at the plant. Cleaning chemicals used at the plant are registered and approved for use in food production facilities, and the company verifies that these chemicals are used at the approved concentrations. Any chemicals used by growers in the production of the Hermiston Foods crops are registered and approved by EPA for use. The plant verifies proper adherence to chemical label use before accepting crops from growers.

9. How much nitrate is in Hermiston Foods' wastewater?

The wastewater contains approximately 1.3 mg/L of nitrate. However that could increase to 35 mg/L as wastewater breaks down in the soil. Irrigation with supplemental fresh water reduces the concentrations.

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10. Does Hermiston Foods test its raw products for pesticide residues?

No. Existing regulations do not require the company to test its raw products for pesticide residues. Hermiston Foods states that it requires its growers to apply any chemicals strictly in accordance with the label.

11. Why does Hermiston Foods wastewater stink while wastewater from other food processors does not?

According to Hermiston Foods, all wastewater has an odor. These odors are associated with the type of food being processed (peas, corn, green beans, carrots, potatoes, onions, etc.). Certain conditions may cause stronger odors from process water. For example, diverting a large load of wastewater to a holding pond and storing it for too long in the summer months will cause stronger odors than quickly applying wastewater quickly.

12. Why doesn't Hermiston Foods discharge wastewater to the city sanitary sewer?

Hermiston's city sewers cannot handle the volume of wastewater produced at Hermiston Foods.

13. Why doesn't Hermiston Foods discharge wastewater to the Simplot system?

Hermiston Foods has decided not to discharge their wastewater to the Simplot system because it was being used by another user. DEQ cannot prescribe what process is best for Hermiston Foods. DEQ's role is to ensure that whatever process the company chooses complies with all applicable, adopted environmental laws.

14. Where can neighbors find well logs for their private drinking water wells?

Well logs for private drinking water wells can be obtained from the Department of Water Resources website: http://apps.wrd.state.or.us/apps/gw/well_log/Default.aspx. You will need your tax lot, section, township and range numbers to find the log for your well. Well logs should include information on the depth of your well, whether it is a basalt well or an alluvial well, the depth of the casing and surface seal, and the perforated interval. You should also be able to see the name of the driller, the year the well was drilled, how it was drilled and possibly whether any repairs or modifications have been made.

15. How does DEQ decide how to handle violations and take enforcement action?

DEQ determines the level of enforcement action to take by following statewide guidance found in Oregon Administrative Rule (OAR) 340-012-0045. (e.g. warning letter, monetary penalty or order), based on the likely impact of the violation on human health or the environment. It then adjusts the penalty based on the duration of the violation, the violator's compliance history, their mental state and cooperativeness in achieving compliance, and the economic benefit gained by being in violation.

16. Has Hermiston Foods over-saturated the soil?

Hermiston Foods' permit prohibits irrigating the soil to the point that it creates run-off from the site and leaching below the root zone. The permit requires the company to monitor soil moisture through the root zone. Based on review of soil moisture logs, there was only one instance when the soil was saturated beyond the limits of the permit: K-3NW, a four-acre field exceeded the limit. The company said this occurred because a sprinkler on the field broke.

Summary
DEQ met with neighbors, managers from Hermiston Foods and representatives of other government agencies at the OSU Experiment Station in Hermiston to facilitate direct dialogue between neighbors and the company. The company outlined measures it has taken and plans to take to reduce odors at the plant. Neighbors voiced concerns regarding odors and health risks. A representative from Oregon's Department of Human services made a presentation on the known effects of odors on people, and DEQ provided background information on nitrates in the area and groundwater monitoring practices.

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Attendance
Invitations were made to 35 neighbors. Eight neighbors attended.

Also present were:

- Larry Givens, Umatilla County Commissioner
- Tamra Mabbott, Umatilla County Planning Director
- Gina Miller, Umatilla County Code Enforcement Officer
- Melissa Newman, Umatilla County Environmental Health Supervisor
- Lisa Hanson, Deputy Director, Oregon Department of Agriculture (ODA)
- Linda Hayes-Gorman, DEQ Eastern Region Administrator
- Duane Smith, Waste Water DEQ Permitting Manager
- Carl Nadler, Waste Water DEQ Permit Writer
- Brian Mannion, DEQ Office of Communications and Outreach
- Rick Hill, DEQ Hydrogeologist
- Phil Richerson, DEQ Hydrogeologist
- Daniel Cain, Oregon Department of Human Services, Public Health Division
- Cyd Bothum, Hermiston Foods
- Roy Stephen, Hermiston Foods
- Mark Sather, Hermiston Foods
- Craig Williams, Hermiston Foods
- Gina Gray, IRZ Consulting
- Mark Steel, NORPAC Foods
- Bill Burich, NORPAC Foods

Hermiston Foods Presentation
Odor reduction measures taken:
The company began the meeting with an update of recent and planned improvements to address odor issues at site. According to the presentation, Hermiston Foods took the following actions:

- Replaced screens with fine mesh, both at plant and at wastewater pond
- Installed drop tubes on pivots
- Dropped height of some pivot nozzles to four feet
- Changed some nozzles to make larger water droplets (less likely to cause drift)
- Reduced irrigation pressure from 55 psi to 42 psi
- Experimented with odor-masking agents and "liquid-live" beneficial bacteria for the pond

Planned odor-reduction measures:
Company representatives said Hermiston Foods is considering the following actions in 2011:

- Plant fast-growing hybrid trees around pond to create physical wind barrier
- Apply only fresh water on field S1
- Flush lines to C1 and C2 before harvest
- Explore flushing system with fresh water to lessen time when water stands in tubes
- Test for need for more aeration
- Assume more direct involvement in irrigation (currently handled by contractor)
- Install a new automation system for K-3 pivot
    - Includes wind monitoring and automated stop/start
    - Could allow faster response to odor incidents

Complaint data:
Hermiston Foods said it has logged all complaints it receives including the name of complainant, time of complaint and weather conditions at the time of complaint. Their analysis found that 77 percent occurred in still weather, most complaints occurred in the evening, complaints are correlated to wind direction and twice to three times as many complaints were filed when wastewater was stored in the pond during summer months. The company said it was still looking at the numbers to identify trends and relationships between weather patterns, irrigation practices and complaints.

Other comments, responses:
Throughout their presentation, Hermiston Foods answered questions from neighbors and presented company views on a range of subjects. The company maintained that the best solution to reduce odors is to apply the waste water directly to fields without storing it, but that DEQ regulations limited the amount of water they could apply and required storage of waste water.
In response to questions, Hermiston Foods said that they investigated the possibility of using the Simplot system, but found that it was being used by another user. The company has not looked into onsite purification measures for financial reasons, and Hermiston Foods will continue to work to reduce odors and with what is proposed for 2011, they would expect odors to be reduced.

When asked about covering the storage pond to reduce odors, the company said that covering might counteract the positive effects of aeration.

Hermiston Food representatives asked neighbors to call the company and give them advanced notice of social events and gatherings so that they can regulate irrigation activities to minimize the potential of odors reaching neighbors.

DHS Odor Presentation
DHS Industrial Hygiene Specialist Dan Cain presented information regarding the effects of odors. This presentation included the following information:

- Odors may cause subjective, objective and emotional symptoms
    - Subjective: nausea, headache

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  - Objective: watery eyes, cough, increased heart rate
  - Emotional: stress, depression
- Unless material is toxic, symptoms end when exposure to the odor ends
- Reactions to odors vary greatly; reactions are affected by other factors including response to stress and sensitivity; women are generally more affected than men

Neighbors asked if there is any risk from airborne bacteria or mold from the spray. Cain said that DHS toxicologists say there is no known risk from this type of land application, but that he would perform a literature search to see if any studies address the issues specifically.

DEQ groundwater information

Neighbors asked how they can be sure Hermiston Foods' activities were not contributing nitrates to their groundwater. In response, DEQ staff provided the following information:

- The entire area is situated in a water quality management area, so it is not uncommon to see higher nitrate levels in management area.
- Base data for area shows wide range of nitrate levels (1.95 - 71 mg/liter); higher levels this year cannot be attributed to Hermiston Foods activities at the site because not enough time has passed for irrigation water to travel into ground water.
- DEQ showed location of 11 test wells on map and explained groundwater movement patterns.
- DEQ explained that test well data was a baseline (obtained before irrigation) because the agency did not let Hermiston foods apply wastewater before installing test wells; three samples taken before land application began.
- The purpose of the permit is to protect groundwater by limiting irrigation.
- It is unlikely that basalt/confined aquifers contributed anything but clean water to test wells.
- Testing has not detected significant drift of nitrates.
- Years of testing data still needed to identify any trends.

Neighbors suggested monthly groundwater monitoring through growing season. DEQ staff explained that groundwater moves at a slower pace, so monthly monitoring would not allow enough time to detect changes in the groundwater attributable to Hermiston Foods' actions. They suggested continuing quarterly monitoring and explained that it would take years of data to identify any groundwater trends.

Neighbor concerns

Neighbors reiterated a number of concerns that they expressed in the September 28 meeting:

- Odor Problems
- Company Response Issues
- Groundwater Concerns
- Potential Overspray
- Affects quality of life and property values

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The neighbors also asked about the potential risk of airborne bacteria and mold from using waste water in irrigation.

Other comments and suggestions

Neighbors asked for a contact list containing information for all government representatives who attended the meeting. They also asked that the complaint and frequency of complaints be plotted on a map of the area.

Next steps

DEQ, DHS and Hermiston foods all agreed to some type of action to address neighbors' concerns, as seen in the table below.

Action	By	Status
Include wind data for all days in complaint data	Hermiston Foods	To be done
Plot complaints (number and type) on full area map	Hermiston Foods	To be done
Notify Hermiston Foods of upcoming events/gatherings at nearby homes	Neighbors	Ongoing
Modify irrigation schedule where possible to accommodate neighbor's social events as requested.	Hermiston Foods	Ongoing
Make test well data available	DEQ	Data is public record. Residents may contact DEQ for more information (see contact information for Carl Nadler on front page)
Contact Troy Downing to discuss how dairy farms deal with odors; report back to group	DEQ/ Hermiston Foods	To be done
Send neighbors contact info for all specialists/government reps involved in meeting	DEQ	Done via email 11/5/10
Perform literature search regarding effects/risk of bacteria and mold in water mist; report findings to neighbors	DHS	To be done

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Date: July 10, 2013

To: Bill Burich, Hermiston Foods
Duane Smith, OR DEQ
Lauren Henderson, OR ODA

Dear Bill, Duane, and Lauren,

Please accept the attached final Best Practices report for odor management in water reuse and the report on Hermiston Foods water characterization with regard to odor.

We used funds provided by Hermiston Foods, OR DEQ and OR DOA to the Agricultural Research Foundation in October 2011 to complete these two tasks related to odor management in water reuse processes. These reports were largely complete, and had been reviewed once by Hermiston foods in late Fall 2012. However, I did not finalize the reports until today, which was an unsatisfactory performance on my part. In January I was promoted to an administrative role in the College of Engineering, and allowed the demands of that position to delay my completion of the final reports. I apologize for this delay.

In staffing this project I employed 8 students and 2 research associates. When I hired these staff, I intended that the material (data, documents, etc.) produced by these employees was for this project and subject to synthesis and modification to complete the project objectives. However, that has been a point of contention with Dr. Dysart. I have tried to satisfy Dr. Dysart with regards to the Best Practices report, and hopefully succeeded. With this submission, it is my position that these two reports are under the control of Hermiston Foods, ODA and DEQ. I will not provide these documents to any other entity and before today have only shared these documents with staff at Hermiston Foods.

I am happy to address comments and suggestions from Hermiston Foods, OR DOA or OR DEQ regarding these reports.

Sincerely,

Christine Kelly

Christine Kelly
Associate Dean, College of Engineering

Cc: Mark Dolan, CBEE; Pat Dysart, CSS

A Report to Hermiston Foods, OR Department of Environmental Quality and the OR Department of Agriculture

REVIEW OF ODOR MANAGEMENT OPTIONS APPLICABLE TO THE FOOD PROCESSING INDUSTRY BEST PRACTICES

Dr. P. L. Dysart
Department of Crop and Soil Science
Oregon State University
2013

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EXECUTIVE SUMMARY

The success of the farming and food processing industries are very important to the economic well-being of the state of Oregon. In the Pacific Northwest, food processing of all types is the third largest manufacturing sector with annual revenues of $21 billion, and more than 100,000 employees. In 2008, there were 197 total food processing firms in the Pacific Northwest (NFPA 2008). The trend has been increasing due to the general pursuit of healthy lifestyles and healthy food choices by the people living in the PNW. The need for healthy, abundant food supplies and relaxed lifestyles, in some cases, has brought the food industry and its customers into contention over malodors and perceptions of 'clean air.'

The incidence of 'nuisance odor' complaints has risen substantially in the past 10 years. The term 'nuisance' is not a pejorative; it is simply a term used to designate complaints regarding odors that are not toxic to human health. There is no provision in the National Clean Air Act that requires the U.S.EPA on the Federal level to regulate non-toxic malodors. These types of complaints are left to the state and local municipalities to handle. Many states and local governments are beginning to specifically address odors in their regulations. As of 2000, 44 of the 50 states have regulations that deal directly or indirectly with odors from concentrated animal feeding operations (CAFOs). Ten states had direct odor regulations, and another 34 states have indirect regulations such as setbacks, manure handling training for workers and shelterbelts (Appendix A Redwine and Lacey 2000).

The U.S. EPA does regulate six (6) air pollutants: particle pollution, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead (USEPA 2012a).

From a public health and diagnostic toxicology perspective, it is essential to know what compounds make up a particular 'odor' and then determine the exposure level that will not cause any adverse health effects. However, since odor perception is a subjective sensation that varies from one person to another, and the human nose can detect odors at such minute concentrations, it is difficult to obtain an accurate, repeatable measurement of odor emissions. New 'electronic' nose technologies (Scentometer, Nasal Ranger®) are being developed in an effort to quantify odor data and standardize emission thresholds.

With the increased regulatory environment, and as part of being good rural neighbors, operator/owners realize there are aspects of animal agriculture (confined animal feeding operations CAFOs), food processing operations (ancillary farm operations AFOs), and municipal wastewater facilities (MWFs) where attention to 'best management practices' can significantly decrease fugitive malodor emissions. For example, two main areas - waste storage and land application of wastewaters generate 80% of all nuisance odor complaints.

Most odor complaints, by far, are generated during land application of wastewaters and solids onto agricultural fields. Land application is a cost-effective, resource conserving disposal strategy. The most common industrial wastewater reused in Oregon originates from food processing activities such as potato processing to smaller activities such as fruit and vegetable processing/packing or viniculture (ODEQ 2012). These waters condition the soil with nutrients and provide needed irrigation water for crops. *Good management practices* include testing of these waters for: total nitrogen and phosphorus, total organics (BOD, COD), suspended solids (TSS), salinity (FDS, EC), cations and anions, pH and boron. If undisinfected rinse water is used for sprinkler irrigation of a fresh market vegetable crop, the rinse water should also be

checked for possible pathogens such as the O157:H7 strain of *E. coli* bacteria (Crites et al. 2007).
In general vegetable food processing residual wastes (FPRs) contain large amounts of organic materials such as proteins and carbohydrates, high biochemical oxygen demand (BOD) or chemical oxygen demand (COD) and large amounts of suspended solids. *Good management practices* for odor control in land applications include separating solids from liquid waste and recycle as much water as possible to thoroughly stabilize the FPR prior to land application, keeping FPR streams well aerated, select land application areas that are distant from neighboring residences, don't spray when neighbors are engaged in outdoor activities (as much as possible), , spread on turbulent and breezy days to dissipate and dilute odors, avoid spreading near heavily traveled roads and clean up any spills promptly, incorporate odorous FPRs into soil immediately; and liming FPRs can reduce biological activity.

Drift and odor during land application are affected by several factors from weather conditions to application equipment per se and transfer pipe maintenance. Drift and odor are competing properties. As wind speeds increase, drift is increased, however, odor is dissipated faster and doesn't linger. Factors affecting drift and odor include: droplet size, height and angle of discharge above ground, discharge pressure, nozzle size and type, and weather conditions.

Good management practices for application equipment design include: reducing TSS, increase droplet size, low discharge pressure, nozzle type, lower discharge height and angle relative to the ground and crop height. (See Tables 4a,4b,6).

Maintenance of transfer pipe and spray equipment cleanliness is also a *good management practice*. Flush transfer pipes from storage containments and spray equipment often with fresh water to prevent anaerobic conditions forming during low flow events and to prevent nozzle clogging with suspended solids. Flushing should take place at the end of the process season as well.

Storage facilities for FPRs, liquid, slurries and solids, are also a potential source of malodor generation. Good management practices to reduce these potential odors from solids include: minimizing unusable material that is brought to the packing house e.g., shelling peas in the field, store culled fruits and vegetables in a bermed area out of the rain or with a cover to prevent decomposition liquids from leaking, return culled fruit/vegetable waste to the field; feed fruit/vegetable waste to livestock, give usable fruit and vegetable culls to local food banks, compost fruit/vegetable culls recognizing the odor potential of open air composting piles left too long, dispose of fruit/vegetable waste in local landfill, and move solid waste piles offsite frequently.

Storage of liquid and slurries in containment facilities such as lagoons, ponds, and temporary holding tanks which have large areas open to the air tend do produce odors if anaerobic conditions occur. *Good management practices* to control odor here are: basin/lagoon covers, mechanical screens (static and dynamic) to separate as much of the solids as possible before pumping into storage, flush pipe transfer lines frequently to and from storage lagoons/pump houses and especially at the end of the operating season, mix fresh water with aerated pond water to maintain aerobic conditions, pH adjustment optimum 6.5-8.5 optimum for aerobic processes, and consider odor control chemicals/masking agents if economically feasible (See Table 6).

Good management practices on a large system wide scale include planting trees around storage facilities (shelterbelts) to trap windblown particulate matter and increase wind turbulence to prevent odors from staying at ground level and creating 'no application' buffer zones between process fields and neighboring residents.

Industry specific odor issues related to confined animal feeding operations CAFOs and municipal wastewater facilities -MWFs are not included in this review.

Comments from the author: I sincerely wish to thank Dr. Dan Burgard of Cascade-Earth Sciences for his vast expertise, Mr. Duane Francisco, National Foods Corp, Mr. Jacob Beach, Smith Frozen Foods, Inc., Mr. David McGiverin of the Northwest Food Processors Association who were gracious enough to share their odor control issues and management methods with me. I wish to also thank Hermiston Foods management, plant personnel and OSU extension agent, Dr. Don Horneck for their time during my plant tours, and Drs. Mark Dolan and Christine Kelly in the Chemical, Biological, and Environmental Engineering Department in addition to the OSU Valley Library Staff for their support and timely article retrieval.

P. L. Dysart, PhD
7-25-12

REVIEW OF ODOR MANAGEMENT OPTIONS APPLICABLE TO THE FOOD PROCESSING INDUSTRY

Project Scope/Definition

This literature review was undertaken by Hermiston Foods Co. in an effort to identify and enumerate a general set of Best Practices for Odor Control as a result of odor nuisance complaints from neighbors during vegetable processing and land application of wastewater to agricultural fields adjacent to the facility located in Hermiston, Oregon. This plant is considered here to be an ancillary farm operation (AFO).

Although there are numerous ways in which to organize and categorize odor source types, it was determined the most effective way to present this information was to categorize source types by the industries that share odor management issues with the vegetable processing industry and they are animal agriculture operations as in Concentrated Animal Feeding Operations (CAFO) and Municipal Wastewater Facilities (MWF).

This taxonomy was developed because the political and institutional reality of CAFO and AFO air emission source types is that they are managed differently from MWF air emission source types in terms of environmental programs.

Most CAFO and AFO odor sources can generally be understood as area or diffuse and uncontrolled sources of odor, the measurement and mitigation of which entails quite different strategies than for those odors arising from point sources (e.g. smoke stacks). In other words, management and control of malodors (best management practices) is industry and site specific.

The significance of a particular odor source is invariably related to operational practices, and this makes the distinction between a source and a control strategy difficult to articulate in general terms. In reality, the most successful best management practices for odor control are site and operation specific.

By far, the bulk of the current literature for the description of malodor sources, identification of odor compound chemistry, and ultimately to devise control methods is primarily focused on handling, storage and land application of manure from CAFOs and biosolids from MWFs.

Information on odor generation from Ancillary Farm Operations such as frozen food processing is extremely limited and the problems and solutions for AFO odor control falls somewhere in between the two and closer to the CAFOs rather than MWFs due to the fact that 99% of the time, the definition of ‘Food Processing’ in the literature refers to ‘meat (swine), poultry/egg, and dairy’ operations, not to fruit and vegetable processing facilities. Most of the literature that does pertain to fruit/vegetable food processing facilities focuses on initial plant design such as site location, process development, and process optimization not odor control.

Even using CAFOs and MWFs as models, many of the CAFO and MWF odor sources and their specific management solutions are not in common with AFOs such as efficient manure removal from hog pens, adequate ventilation of an overcrowded swine barn, and remediation of toxic effluent streams.

Examples of appropriate areas of overlap that are covered by this review are waste storage and land application of non-toxic effluents; for example, wastewater storage lagoons and land application of 'manure' from animal ag operations; 'biosolids from municipal sewage plants, solid fruit/vegetable culls, solid food processing residuals (FPRs), and waste/rinse water from normal food processing operations. The common disposal strategy for handling all of these wastes (liquids, slurries, or biosolids) is to spread the effluents onto agricultural fields for either soil nutrient enrichment or crop irrigation purposes. This is a cost-efficient and resource conserving strategy. Unfortunately, the land application process is responsible for typically more than 50% of all nuisance odor complaints from residents living at the rural-urban interface (Sheffield et al. 2008); 20% from waste storage, and 30% from production buildings (SRF 2004; Marsh and Krapetyan 1999).

This review is *not* intended to elaborate in detail on any particular company or farm operation per se. It does not address reducing odor through process optimization. It is not intended to present a comprehensive discussion on every aspect of malodor management from all industries.

Not relevant and outside the scope of this review are best management practices based on facility location and design, pre-treatment of effluent streams (unless directly FPRs), proprietary operations and maintenance, toxic odor management, total maximum daily loads (TMDL) water/soil loading, etc. and slaughter houses.

In additional to the report bibliography, a selected list of Additional Reading Resources is compiled in Appendix F in 7 categories:

1. Gaseous Emissions from Wastewater Facilities
2. Food Processing Wastes
3. Agricultural Wastes
4. Health Effects
5. Broiler Facilities Odor Concentration & Emissions
6. Odor Measurement - Instrumentation
7. Shelterbelts

The reader is advised to use the material and references presented here to generate a set of best management practices for odor control that are site, category, source, and process specific to their own operation.

This review contains three sections and several appendices as described below:

Section I – The Odor Struggle
- Why have nuisance odors increased in recent years?
  - Rural Migration
  - Prized Real Estate
  - Quality of Life vs. Consolidation and Increased Food Production
  - Perception
  - FIDO
  - Subjective vs. Quantitative Data
- General Regulatory Responsibility
  - Agency oversight (local, state and federal responsibilities)
  - Health Concerns of Malodors
  - What is a Nuisance?
  - What is a Nuisance Odor?
  - State Nuisance Odor Definitions

Section II - Odor Primer
- Odor Pathway
- Odor Release
- Odor Transport and Dispersion
- Odor Detection and Measurement
- Characterization of Odors

Section III- Best Management Practices
- Common areas of malodor generation in the target industries
- Common odor control solutions
  - Animal Agriculture
  - Municipal Waste Facilities
  - Food Processing

Appendix A Redwine CAFO state by state summary table
Appendix B GEIS Jacobson Minn. State by state regulations
Appendix C SRF summary state by state summary table
Appendix D USEPA State Websites for Water Reuse
Appendix E Definitions
Appendix F Additional Readings

SECTION I – The Odor Struggle

Why Have Nuisance Odors Increased in Recent Years?

Rural Migration

According to the US Department of Agriculture, rural America is home to about 17 percent (50 million) of the Nation's people, comprises over 2,000 counties, and accounts for 75 percent of the Nation's land (U.S. Census 2010). Although the rural migration growth has slowed from 4.1 million during the 1990's, rural counties gained 2.2 million residents to reach a population of 51 million in April 2010 The rural population gains were greatest in the West and Southeast and in those rural counties designated as recreational or retirement counties by the USDA (Johnson 2012). Recreational amenities such as clear lakes, ski slopes, golf courses, and open space attract retirees and the creative classes seeking an alternative to the hectic pace of urban life (Johnson 2012). While at the same time, the nation has lost 41,324,800 acres of rural land to development between 1982 and 2007 with 23,163,500 acres or 56 percent identified as active agricultural land (Figure 1 and 2). Although migration to rural areas has slowed since the 1990, it still is taking place at a significant rate (Morrill 2010).

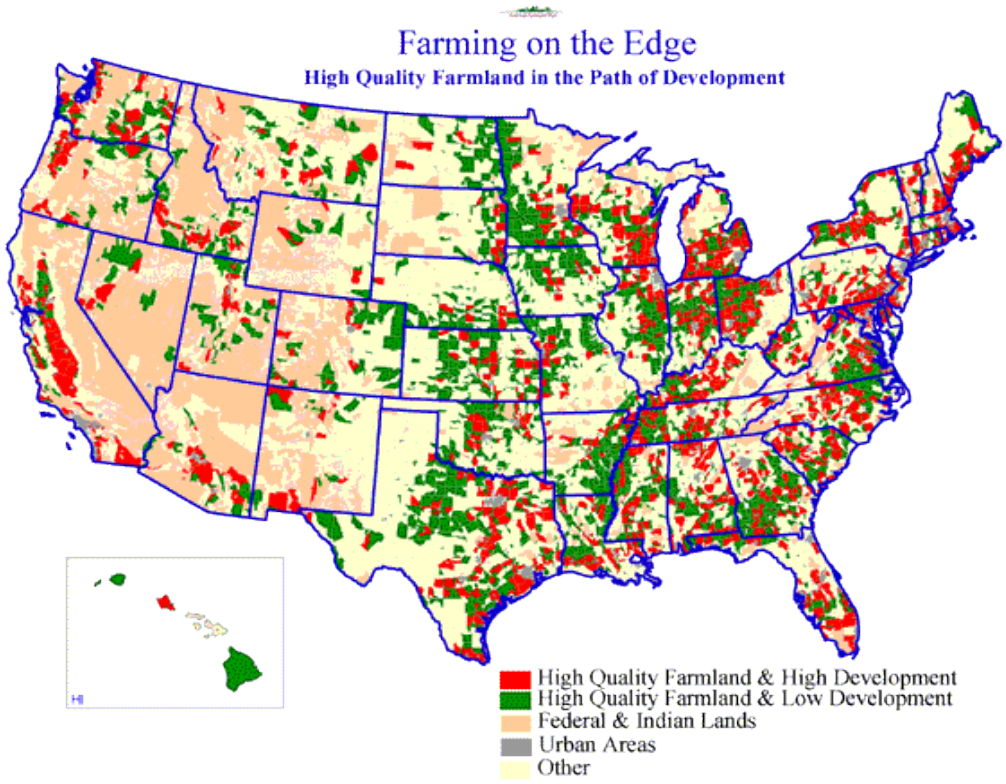

Figure 1. US Development impact on quality farmland.

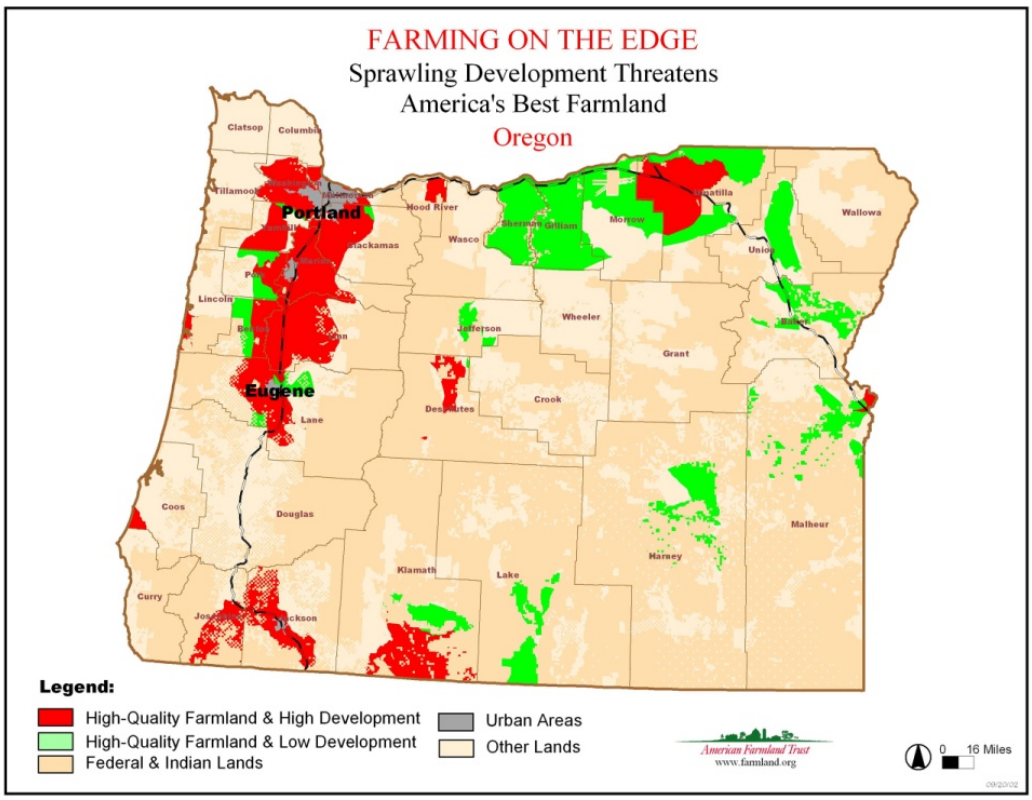

Figure 2. Oregon development impact on quality farmland.

Oregon's statewide Land Use Planning Program is perhaps the strongest and most effective program of its kind in the nation. By this means, Oregon has protected some 16 million acres of land in what are called 'exclusive farm use zones' (EFU). This has to be among the strongest records of accomplishment anywhere in the country (American Farmland Trust 2012).

Although the Oregon Department of Land Conservation and Development's (ODLCD) Farmland Protection Program is the best in the country, there are certain types of 'non-farm dwellings' allowed within EFU zones (ODLCD 2012) and urban residents seeking simpler lifestyles gravitate to homesteads either in an EFU or adjacent to its boundaries.

Prized Real Estate

The qualities that constitute 'Prime Agricultural Land' also make this same land highly sought for real estate development while at the same time farm operations and/or ancillary farm operations such as fruit/vegetable/meat food processing plants have intensified operations to meet the growing demand for commodities (Sheffield et al 2008; Brandt and Elliott 2004). Figure 2 shows the parts of Umatilla and Morrow Counties that fall into the high-quality farmland & high development category (American Farmland Trust 2012).

As developments push closer, a number of nuisance problems have emerged. Unpleasant odor emissions originating from farm or ancillary farm operations are perhaps the number one complaint (Sheffield, et al. 2008; Brandt and Elliott 2004; Bottcher 2001) with swine/poultry operations.

Quality of Life vs. Consolidation and Increased Food Production

The odor struggle between production facilities of all kinds and neighbors is not new and is as old as animal domestication itself. Its record in legal history dates as far back as 1611 when a neighbor filed suit under British common law, claiming that a hog farm was creating an odor infringing on his right to enjoyment of his property (SFR 2004). What is new is the rise in odor nuisance complaints that has occurred, in part, because urban residents have moved to the country determined to have fresh air. Once people make the move to the 'country,' they find that the 'clean country air' often contains many odors too, and some not so pleasant. Residents complain that odors are more than just annoying. They claim such odors diminish their comfort, quality of life, and property values (Brandt and Elliott 2004; Heber 2004; Tyndall and Colletti 2000; Miner 1995).

Not only have odor disputes increased because more people are moving to the country, but by far, the most nuisance odor complaints are generated by confined animal feeding operations (CAFOs) and in particular swine and poultry facilities. Livestock agriculture facilities in the United States have also increased both in size and abundance in response to the increasing demand for food (Heber 2004; SERC 2004) and due to perceptions that large operations benefit from economies of scale in terms of expenditures for labor, feed, and facilities have caused producers to try to capture those potential benefits (Tryndall and Colletti 2000; SOTF 1995).

This expansion has caused the open space 'buffer' zones between CAFOs and new residential homes or developments to become significantly reduced. Swine and poultry CAFOs have the most odor complaints filed against static operations (lagoons, housing, etc), and land application of wastewater/manure systems whether they be from animal operations, municipal sewage plants, or food processing facilities generate the most complaints of the dynamic operations.

However, these industrial and agricultural process waters have reuse resource value in land applications as soil conditioners and irrigation water. The most common process waters reused in Oregon originate from food processing activities, including large scale industrial processes such as potato processing to smaller activities such as fruit packing or viniculture. Food processing waters often include nutrients, such as nitrogen, which may be used to supplement or replace some of the chemical fertilizer used in agriculture. However, the physical, chemical, and microbiological properties of industrial wastewater can vary widely based upon the type of industrial activities which can also limit reuse applications (ODEQ 2012).

It is recognized that some external odor is unavoidable in certain agricultural operations, and there are practical limits to what farmers and food processors can do to limit odor. Producers argue that they have as much right to the air as the newcomers, and since they were there first, they should be allowed to continue doing their work in the same fashion. After all, odor was not an issue until the residents began to live near them (Brandt and Elliott 2004; Tyndall and Colletti 2000; Williams 1996).

Nuisance odor complaints go beyond the farmer/neighbor interactions in the country, and are generated wherever there is a facility that generates external odors (pleasant or unpleasant) during normal process operations such as food processing plants, 'flavor' factories and to liquor distilleries and wineries. Even smells considered to be pleasant by some like cherry cough drops, maple syrup and liquor such as those released during normal process operations by Wild Flavors in Erlanger, Ky., Frutarom Co. in New Jersey which processes fenugreek seeds for food additives, and Jim Beam distillery in Cinn., Ohio, have generated complaints from neighbors. None of these companies have violated any rules or laws (OCAL 2011; Gothamist 2009)

Perception

The subjective differences in the perception of odors play a role too. Because odor detection and evaluation varies among individuals, one person cannot determine whether a smell is offensive for an entire population. A person whose livelihood depends on animal agriculture or in the case of people working in an ancillary operation such as fruit/vegetable processing plant who have been working around a certain smell for years may not regard the odor as offensive.

The psychological response to odors is more complex and less well understood than the physiology which has been extensively explored during the past thirty years. Individuals react differently to the smell of any particular odor source. There are experiences of people who react to swine lagoon odors with an emotional intensity that others would find entirely unreasonable. Recent observations suggest that these are honest and accurate reactions. Whether these responses are so intense because they have an objection to the odor source based on other factors is unclear at this point (Miner 1995)

Nuisance lawsuits describe citizens' perception of the general decline in their neighborhood quality of life include legal terminology such as: 1) personal discomfort, inconvenience and annoyance 2) loss of enjoyment of personal property, and/or 3) diminished property value or rental value. There is a subset of citizens from this population who indicate they are experiencing non-specific symptoms such as headaches, nausea, reflex nausea, G.I. distress, fatigue, eye irritation, throat irritation, and classical stress responses, etc.

Although, these nuisance claims rarely include the health effect component to the citizens' discomfort and annoyance, there is a 'gray line' between odor nuisance and actual health effects (McGinley and McGinley 1999). While these health concerns play some role in the citizens' complaint, it is still unknown whether these non-specific symptoms are a direct or indirect result of the odor. For example, is a headache due to a physiological change caused by the presence of a chemical odorant (define odorant) (different from odor which is non-chemically based) or is it because the citizen is 'simply annoyed' (McGinley and McGinley 1999).

It is also important to realize that people tend to adjust to smells over time. A person acclimated to a particular smell doesn't even notice a routine odor while a new resident will become immediately aware of a smell (Brandt and Elliott 2004).

FIDO

The non-farming community usually views odors as strictly a nuisance; however, in some cases through the lack of understanding or tolerance neighbors relate malodors with chemical toxicity of the air, soil and water, but not all malodors are toxic. On the other hand, some very dangerous chemicals have either a mild odor (gasoline) or no odor (carbon monoxide). In fact, many of the most toxic substances in air do not have any odor, and others like alcohol or benzene may give off what some perceive as a pleasant odor (OHA 2010; USEPA 2004; GDHR 2004). However, a small amount of a bad odor can make individuals feel ill immediately and reduce their quality of life (OHA 2010; USEPA 2004, GDHR 2004; Miner 1995). The effects are not usually permanent and can be related to what are called FIDO parameters (frequency, intensity, duration, offensiveness (hedonic tone)) of the odor itself (Brandt and Elliott 2004; Marsh and Karapetyan 1999). Hedonic tone is the perceived offensiveness of certain smells that can be measured only through qualitative means. If all four factors are of long duration, the odor becomes a nuisance.

Many environmental odors particularly from CAFOs, MWFs, and AFOs are not pure compounds but rather complex mixtures of ammonia, hydrogen sulfide, skatole, indol, amines and mercaptans (Brandt and Martin 2001) which are externally generated from manure and biosolids and primarily anaerobic digestion processes. Although there have been over 160 volatile organic compounds (VOCs) and gases identified as coming from CAFOs, there are a few principal culprits such as ammonia and hydrogen sulfide. These compounds have an associated distinctive, characteristic unpleasant 'smell' and are related to the type of residual waste produced. For example, wastes from CAFOs and MWFs are primarily VOCs, meat processing plants will contain a high fat and protein content while waste from the canning industry will contain high concentrations of sugar and starches (UNIDO).

In general, wastes from the food processing industry have the following characteristics: large amounts of organic materials such as proteins, carbohydrates, lipids, varying amounts of suspended solids, and high biochemical oxygen demand (BOD) or chemical oxygen demand (COD)(Litchfield 1987).

Subjective vs. Quantitative Data

To assist regulators as well as all parties concerned solve some of these odor perception issues, new objective FIDO measurement technologies such as 'nasal organoleptic instruments have been developed. These 'electronic noses' and/or scentometers such as the Nasal Ranger Field Olfactometer® (St. Croix 2012) and OdoWatch E-Nose (Odotech 2012) are among the new instruments which provide field olfactometry using objective scientific methods for quantifying repeatable ambient odor data on which to base regulation rather than on subjective 'this place stinks' observations.

General Regulatory Responsibility

Agency Oversight (local, state and federal)

Federal environmental regulations are administered by the United States Environmental Protection Agency (USEPA). The USEPA has no standards specifically pertaining to malodors. The USEPA does not regulate odors. (USEPA Dysart pers. comm. L. Elmore 5/9/12; SERC 2004; Miner 1995). Odor may be defined as an air contaminant but is not defined as an air pollutant under the federal Clean Air Act (USEPA 2012a). This position is founded on the belief that most agricultural odors are of transient importance and are 'merely a nuisance unless the ingredients are toxic' (Sweeten and Levi 1977). Probably the main reason for the belief is that nearly all odorous substances are nontoxic, biodegradable (organic) or highly reactive inorganic compounds, and do not irreparably damage or pollute anything. Medical opinion is that odors are merely a nuisance unless the ingredients are toxic (Sweeten and Levi 1977).

The USEPA does regulate six (6) air pollutants: particle pollution, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead (USEPA 2012a).

Essentially all odor emission regulation is administered at the state and local levels. The Oregon Department of Environmental Quality has a set of published guidelines for land application of industrial and agricultural process waters (Pour 1992) and Oregon Senate Bill 212 (2001) allows the land application of reclaimed water, agricultural and industrial process water, and biosolids for agricultural, horticultural or silvicultural production on land zoned Exclusive Farm Use (EFU) (ODLCD 2003).

The Oregon Dept. of Agriculture (ODA) is charged with the investigation of situations that would cause pollution of public waterways. The department does not regulate odor, dust, or nuisance complaints caused by normal farming (ODA NRD 2012).

Health Concerns of Malodors

An odorous biosolids product or a biosolids treatment process that results in odor emissions may be perceived an unhealthy due to the origin of the solids. The cause of health complaints in the absence of irritation or toxicity is poorly understood (USEPA 2000; Schiffman et al. 2000)

Federal Biosolids Regulations do not regulate odors because it was believed that odors from land application did not present human health effects (USEPA 2000).

Typical FPRs contain no toxic organics and have no more heavy metals than natural soil. After all, FPRs are derived from food grade materials that have undergone thorough inspection. Principal components of FPRs include water, carbohydrates proteins, and fats. They are often similar to the raw agricultural product (Brandt and Martin 2001).

Without a detailed identification of the compounds comprising the malodor, health risks by the EPA cannot be determined.

What is a Nuisance?

A nuisance is defined as any unreasonable interference with a person's enjoyment of his/her property (Brandt and Elliott 2004).

When common law was first developed, an overriding principle was that a landowner had the right to use and enjoy his land as he wished. The concept of nuisance had no legal basis. With time it became obvious that neighboring landowners might choose incompatible property uses. The use of land by one landowner can clearly conflict with the responsibility not to interfere with another's right to enjoy his own property. Nuisance laws attempt to solve this conflict with the concept of 'reasonableness.' An unreasonable interference with a person's right to enjoy their property is now legally a nuisance (Brandt and Elliott 2004; McGinley et al. 2000). The rules governing unreasonable interference are similar in all states (Sweeten and Levi, 1977).

What is a Nuisance Odor?

A Nuisance odor is an unpleasant smell usually caused by odorous gases and volatile organic compounds (VOCs) being released into the air or when fine effluent droplets evaporate releasing dissolved gases into the atmosphere (Shaffer and Shah 2008). These volatile organic compounds are organic acids, they evaporate easily and if conditions are not correct, excess volatile organic compounds are generated and can cause an unpleasant smell (Zhao et al 2007).

Nuisance Odor Definitions

Nuisance odor law criteria vary from community to community and from state to state (McGinley et al.2000), and regulatory agencies struggle with developing nuisance odor definitions, as well as measurement, and enforcement practices. The first challenge is to develop a definition on which to base regulations or guidelines that both avoid odor annoyance conditions and are not excessively conservative (Mahin 2001).

The following statements taken from McGinley et al. (2000) are examples of how some states have tried to develop 'nuisance definitions':

> air contaminants (including odor) in quantities and duration to injure human health and welfare (Alabama)
>
> unreasonably interfere with enjoyment of life and property (Alaska)
>
> unreasonable interferes with the comfortable enjoyment of life or property of a substantial part of the community (Arizona)
>
> which causes injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public (agricultural odor exempt) (California)
>
> odor constitutes a nuisance if it unreasonably interferes with the enjoyment of life or use of property. (Connecticut)
>
> odors beyond his property…to create a public nuisance…defined includes affecting a considerable number of persons and injurious to health or interfere with the comfortable enjoyment of life and property (Montana)

But what's 'unreasonable interference?' For that matter, what's 'quality of life?' These are legal and philosophical questions that are being asked more and more among state regulators, but mainly for odor emissions emanating from large concentrated animal feeding operations (CAFOs) particularly hog and poultry operations, not for food processing facilities.

A typical approach is to consider that an agricultural enterprise in operation for at least a year without causing a nuisance is not considered a nuisance even when new neighbors arrive.

Whether it can be consistently defined or not, there are a wide range of odor regulations, standards and rules across the country (SRF 2004; Nat. Hog Farm 2001; Redwine and Lacey 2000; Jacobson et al 1999). These odor regulations are standards primarily for CAFOs and MWFs. Not all regulations are concerned with air quality and most, if not all, exempted agricultural operations in the growing of crops, raising of fowls or animals, or composting facilities from public odor nuisance laws particularly if 'best practical control methods' were being used.

Depending on interest, e.g. whether a state has a regulations or guidelines, methods of control, method of measurement, penalties, etc., the tables presented in Appendices A-D, provide a state by state overview of the available information:

> According to Redwine and Lacey (2000), 44 of the 50 states have regulations that deal directly or indirectly with odors from hog farms (CAFOs). Ten states have direct odor regulations, which means they have specific rules that prohibit odor emissions greater than their state standard. Another 34 states have indirect regulations such as setbacks, permits, public comment periods and manure handling training as methods to reduce odors from feedlots. See Appendix A for the state by state table based on Redwine and Lacey (2000).
>
> A GEIS review by Jacobson et al. (1999) indicates that most states do have either guidelines and/or regulations for air contaminants that may adversely affect human health or welfare, animal life, vegetation, or property. See Appendix B for a state by state summary of odor

regulations in general complied by the North Dakota Office of Attorney General.

Appendix C is a summary of SRF (2004) findings from their review of national odor policies for CAFOs, MWFs and describes regulations, determination criteria, penalties, etc.

Appendix D is listing of state websites from the USEPA (2004) as to whether they have regulations or guidelines regarding water reuse.

Because of the technical difficulties of defining a maximum allowable odor value, the existing regulatory framework does not easily address odors. New technologies are being developed to determine quantitative values for odors which would enable regulatory agencies to establish maximum emission rates for odorous compounds, but first these compounds have to be identified and quantified for their nuisance value which is again based on subjective personal opinion.

Section II – Odor Primer

Odor Pathway

For an odor to become a nuisance, four basic ingredients are required: a malodor source, odor release, off-site odor transport, and odor perception. If any of these four factors are absent, no odor problem exists (Brandt and Elliott 2004)

It follows that management involves examination of these factors to find the best point(s) at which to interrupt the odor pathway and avoid complaints.

Odor Release

When an unstable organic waste is in a liquid or slurry form, decomposition gasses accumulate until fluid saturation is reached, beyond which point vapors are released. Whenever these materials are agitated, gas release is dramatically increased. This fact helps to explain why odor emissions can actually increase when aeration is first added to anaerobic treatment facilities, and why manure storage pit agitation and spreading is often accompanied with severe malodor emissions. Covered storage and treatment facilities in some cases are the most effective and practical means of odor control (Brandt and Elliott 2004). Another related issue is the loss of gaseous ammonia (NH_3) during wastewater applications. Although other organic gases in wastewater are likely the predominant causes of odor, ammonia (NH_3) is a pungent gas and can contribute to odor during land applications. Irrigation of anaerobic hog lagoon effluent can result in loss of one-third to one-half of the applied N through ammonia volatilization (Balla 2007).

As far back as 1900, it was recognized that the most common pollution characteristic of industrial wastes is an affinity for oxygen. This may be a chemical or biological demand or a combination of the two. When the dissolved oxygen (BOD) in a liquid or solid stream is depleted, people begin to regard it as an odor nuisance, so the bio-chemical demand of industrial wastes is regarded as a measure of the degree of their offensiveness. Management of BOD has been one area of research ever since.

Odor Transport and Dispersion

Odors are often low density gasses. Once released into the environment they are transported by wind, and diluted and dispersed by atmospheric turbulence. The odor detection threshold is the point at which an increasing concentration of an odor sample becomes strong enough to produce a first sensation in 50 percent of the people to whom the sample is presented. This is distinguished from the recognition threshold, at which point the odor can be identified (Miner 1997).

Nearly all odorous compounds result from biological degradation of organic matter (primarily proteins). Because individuals detect odors at different levels, the range for detection thresholds can be wide. Management of odor emissions containing low detection threshold compounds is considerably more problematic (Zhu and Jacobson 1999; Brandt and Elliott 2004).

Wind is responsible for the rapid horizontal transport of humidity, warm air, pollutants, and odors while turbulence is responsible for vertical transport. Wind turbulence can be visualized as eddies of different sizes that cause fluctuations in concentration over short time intervals. The human olfactory system is able to detect variations of concentration within very small lapses of time. For short exposures, the efficiency of our sense of smell is high. Even though the mean concentration lies under the olfactory perception threshold, our fast reacting and sensitive olfactory system will detect peak concentrations of odor. Hence, concentration fluctuations can be very important in odor problem situations. Two factors contribute to these variations: the meandering of the source plume, and the concentration profile inside the plume. Plume eddies act in a vertical direction, serving to mix and diffuse the plume over distance. As a result, odor concentration fluctuations become less important with distance from the source (Pope and Diosey 2000; Miner 1997; Brandt and Elliott 2004).

Odor Detection and Measurement

<u>Characterization of Odors</u>

In this technological age, many mistakenly believe that odors can be readily detected, characterized, and quantified. Environmental odors are not pure compounds and over 160 volatile organic compounds (VOCs) and gases have been identified as coming from CAFOs, with a few principal culprits such as ammonia and hydrogen sulfide. Despite advances in analytical procedures, most odors are so complex and detectable at such low concentrations that isolating them is impractical. The ultimate odor-testing device is the human nose and today revolves around perception by people based on subjective reactions. Hence, odor detection remains a qualitative measurement. Odor perception has four dimensions: detection, intensity, character, and acceptability (Brandt and Martin 2001;Miner 1995).

The olfactory mechanism responsible for a compound's different detection threshold is not well understood, as such, these thresholds cannot yet be accurately predicted. Rather, they must be measured through extensive tests using human subjects in laboratory settings (Redwine and Lacey 2000; Marsh and Karapetyan 1999; Miner 1995)

The FIDO factors: frequency (how often does it occur), intensity (strength of the odor), duration (how long can the smell be detected), and offensiveness (hedonic tone) are the primary factors on which odors are characterized.

Olfactometry which relies on human detection is currently the most accepted procedure for odor measurement. Scentometry uses hand held measurement devices such as the Nasal Ranger® that allows on-site sampling of odorous air. The instrument was originally developed by the U.S. Public Health Service and was manufactured by Barnebey Sutcliffe Corporation (McGinley et al. 2000). The scentometer device allows air to be divided into two streams, one for odorous air and a second for non-odorous air. There are no standards for describing various scentometer DT levels (DT = dilution to threshold)(McGinley, et al. 2000;Sweeten and Miner 1993; Taraba and Williams)

From a public health and diagnostic toxicology perspective it is essential to know what exposure level will not cause any adverse health effect. This level is usually referred to as the "no observed adverse effect level" (NOAEL)(Eaton and Klaassen, 2001). Usually a NOAEL in laboratory animals is based on chronic exposures ranging from ninety days to two or more years depending on the species. The inhalation toxicity for gases or aerosols, including particulates, is often expressed as the concentration of material (i.e. the weight of compound per volume or weight of air). The no-effect level is the largest dosage or concentration that does not result in detrimental effects. In industrial hygiene, the concept of protecting human health from exposure is quantified to an assumed normal work day exposure and given a value called the Threshold Limit Value (TLV), which includes a safety factor between exposure allowed and concentrations where adverse effects may be expected.

There are odor evaluations that can be performed by chemical means such as wet chemistry, detector tubes, electrochemical sensors, semiconductor sensors, gas chromatography, mass spectroscopy and well as other 'electronic nose systems for automated detection and classification of odors, vapors and gases. Detailing each of these is outside the focus of this review.

However, experts agree that the human nose remains our best instrument for measuring odors (Brandt and Elliott 2004; Marsh and Karapetyan 1999)

SECTION III – Best Management Practices

This section generally enumerates areas where and how malodors may be generated in each category, but details solutions only for those areas in common with food processing waste disposal.

Animal Agriculture

Animal agriculture operations involve the care and raising of dairy, poultry, swine, or other livestock. Odor conflicts arising from animal agriculture invariably involve housing, ventilation, and/or manure management (Brandt and Elliott 2004; Sheffield et al. 2008)

Odorous gases can be produced at a number of sites around a livestock enterprise. The most common odor sources, however, are the floor and other surfaces of buildings and pens, the surfaces of animals, the manure collection and storage facilities, feed storage facilities, dead animal disposal and storage areas, and manure exposed to the air during land applications (Miner 1995).

The literature on the odorous compounds identified in livestock wastes or in the air around them found a total number of 168 identified compounds, 30 of which have a detection threshold of

0.001 mg m^{-3} or less, hence are most likely to be associated with odor nuisance (O'Neill and Phillips 1992). Malodors include a mixture of numerous offensive compounds and are usually transient as a result of natural chemical or biochemical processes as a sequence is followed from the waste itself in its immediate vicinity to the air itself (O'Neill and Phillips 1992).

Odorous compounds are contained in four major categories: Volatile Fatty Acids (VFA's), Indoles and Phenols, Ammonia and Volatile Amines and Volatile Sulfur Containing Compounds.

Table 1 is a list of select odorous compounds (in manure) and their general odor description (Brandt and Elliott 2004; Lacey, et al. 2004; Zhu and Jacobson 1999; O'Neill and Phillips 1992; Lue-Hing, et al. 1992)

Table 1. Select odorous compounds (in manure) and their odor description (character)

Compound Category	Odor Description (character)
Volatile Fatty Acids (VFAs)	Vinegar-like, pungent, rancid butter, offensive
Indoles and Phenols	Fecal, nauseating, phenol-like, medicinal
Ammonia and Volatile Amines	Pungent, irritating, decaying flesh, fishy, putrid, ammonia
Volatile Sulfur Containing Comp	Rotten eggs, rotten cabbage, skunk

Volatile Fatty Acids (VFAs) are produced during the decomposition of proteins and carbohydrates. These VFA's are an intermediate product in the anaerobic fermentation of biological wastes to methane (CH_4). When conditions are such that an incomplete fermentation occurs, then VFAs can be volatilized to the atmosphere. The pH of the decomposing material will, to a certain extent, determine the breakdown products. The odor descriptors associated with these compounds are pungent to distinctly unpleasant to offensive and long chain (greater than 10 C-chain) are mostly responsible for odor generation (Brandt and Elliott 2004; Zhu and Jacobson 1999). When the reaction is complete, the raw biogas usually consists of 60% methane (colorless and odorless), 40% carbon dioxide, water, and trace amounts of hydrogen sulfide (Wilkie 2005).

Indoles and Phenols and other related compounds are produced by microbial (bacterial) decomposition in the intestinal tract of animals. Fecal, nauseating odors are characteristic of compounds in this group.

Ammonia and volatile amines are the product of bacterial decomposition of proteins (deamination and decarboxylation of amino acids) and urea hydrolysis (resulting in ammonia release under neutral pH 6-7) are the primary mechanisms for the formation of these odorous compounds (Brandt and Elliott 2004; Lacey et al. 2004; Zhu and Jacobson 1999;

Odorous volatile sulfur-containing compounds are produced by bacterial activity involving sulfate reduction and metabolism of sulfur-containing amino acids (Brandt and Elliott 2004; Zhu and Jacobson 1999; Leffingwell & Assoc. 1989-98).

The Biological Link

Organic matter decomposes through two basic biological mechanisms. In aerobic decomposition, microorganisms that require an oxygen rich environment perform the breakdown of proteins and carbohydrates to smaller molecular forms needed for metabolism. The primary gaseous end-product is carbon dioxide. In anaerobic decomposition, a different set of microorganisms uses compounds other than oxygen for metabolism. Under these conditions,

the end products of decomposition can include high odorous compounds such as hydrogen sulfide (rotten egg odor) (Brandt and Elliott 2004).

If aerobic conditions predominate, then initial odors dissipate and further generation of malodors in minimized. If anaerobic conditions predominate, then formation of odorous gases continues or even accelerates. Changing environmental circumstances, such as from aerobic to anaerobic conditions or visa versa, will change the nature of odor emissions from a particular source.

While there are exceptions, the typical temperature and pH range required for proliferation of bacteria responsible for odor generation is 68-104 º F and a pH of 6 to 8. The majority of odor generating bacteria thrive around 86 º F and neutral pH (7). This observation helps to explain why odors are much more pronounced during warm weather conditions. While elevated pH (above 9.0) significantly reduces biological activity, it also enhances ammonia release due to chemical equilibrium factors (not a biological phenomenon) (Brandt and Elliott 2004).

Management

Exterior manure storages may be either above or below ground. Storage tanks may be made of concrete or some other impervious material and the tanks may be partially covered to reduce the rate of air exchange between the manure and the ambient air. The tanks are generally not agitated until immediately prior to emptying. Agitating a previously quiescent tank of manure will release a large quantity of potentially lethal gases. Most odor complaints occur when the tanks are agitated or being emptied. If manure is being loaded into a trailer or truck mounted tank, agitation and splashing should be minimized (Miner 1995)

A second popular manure management system includes the incorporation of an anaerobic lagoon. Lagoons provide a low cost means of manure storage and treatment. They provide an opportunity for anaerobic bacteria to convert manure volatile solids into liquids and gases such as methane and carbon dioxide. Lagoons result in a large portion of the nitrogen originally in the manure escaping to the overlying air. Proper lagoon design and management are intended to achieve a relatively low intensity odor release. This approach is effective most of the time; however, during the late spring as water temperatures increase, elevated odor levels are more frequent (Miner 1995).

Odor concerns around anaerobic lagoons include the ongoing escape of odors from the surface and the more extensive escape at the time of removing liquid if it is applied to land using conventional irrigation equipment (Miner 1995).

One solution for odor control around an anaerobic lagoon is to lower the loading rate, increasing the volume of lagoon relative to the organic loading. In other words, have less solids and more water. The more overloaded a lagoon, the more odorous it usually is (Miner 1995).

Another approach is to reduce the actual airflow over the pond surface by erecting windbreak walls around the perimeter of anaerobic ponds at the liquid level which might reduce convection of odorants from the lagoon. According to Borrelli et al. (1989) and Rosen (1976) barriers like any obstruction of air flow, bring about three effects on their environment. First, the flow of the approaching wind is changed in magnitude and direction before it crosses the barrier. Second, the leeward air flow pattern is changed. Third, changes occur in the microclimate (temperature, vapor pressure, and evapotranspiration) surrounding the barrier. All of these changes affect odor transport and dispersion patterns.

Bottcher et al. (1999) carried out windbreak wall experiments to evaluate how effective they might be if the windbreaks were placed downwind of exhaust fans from ventilated animal (swine) buildings. Results from their fan experiments found that windbreak walls caused a jet of air to exit above the top of the windbreak wall at approximately a 30º angle and the plume was observed to flow at least 4 m above the lagoon surface. This deflection upward was a positive for odor flow and dispersion.

Liu et al. (1996) numerically simulated the effect of tall barriers and predicted reductions in lagoon odor emissions from 26-92% for a range of barrier distance to height ratios.

Natural windbreaks, rows of trees and other vegetation known as shelterbelts may also have value as odor control devices around lagoons and buildings. Shelterbelts are inexpensive, especially if the cost is figured over the life of the trees and shrubs, but it may take 3 to 10 years to grow an effective vegetative windbreak (Hernandez et al. 2012; Ma et al. 2010; NRCS 2010; Jacobson et al. 2001; Wang and Takel 1996)

Chemical and biological additives, masking agents, and other products have been proposed. They are commercially available for use in lagoons or manure storage systems; however, federal, state, and local laws do not allow specific chemical additives. There is little supporting data, however, to document the success of these materials (Miner 1995).

Lagoon covers have also been proposed. Impervious covers, rubber or plastic material, have been installed on several industrial waste anaerobic lagoons, slaughter houses, packing plants and food processors. The captured gases can be burned or can be deodorized by venting into a soil bed.

Aeration is an alternative that is available to designers of lagoons and other storage units. By the addition of mechanical aerators, the anaerobic process can be converted into an aerobic one with the associated odor control benefits. Most often when an aeration process is selected, a portion of the organic loading is removed by some other process, either sedimentation or screening to separate the solids. One potential manure handling system would include a solid liquid separator followed by an aerated storage lagoon. Another option would be a covered anaerobic lagoon followed by an aerated lagoon (Miner 1995).

Municipal Waste Facilities

Table 2 illustrates that there are numerous potential odor sources from wastewater treatment facilities and food processing operations.

Table 2. Potential Odor Generation from Common Unit Processes in a Wastewater Treatment Plant (After WEF, 1995 after USEPA 1973, modified by Brandt and Elliott, 2004 to eliminate processes from the list that clearly do not apply to food processing wastewater treatment). (All processes listed may not apply to all food processing operations e.g. dewatering FPRs, composting).

Process	Odor Potential
Liquid Stream Processes	
Flow equalization	High
Sidestream returns	High
Preaeration	High
Screening	High
Grit removal	High
Primary clarification	High
Stabilization	
Suspended growth	Low
Fixed film	Moderate
Chemical	High
Secondary clarification	Low
Tertiary filtration	Low
Disinfection	Low
Solids Processing	
Thickening/holding	High
Aerobic digestion	High
Anaerobic digestion	High
Thermal conditioning	High
Storage lagoons	High
Dewatering	
Vacuum filter	High
Centrifuge	High
Belt filter	High
Filter press	High
Drying beds	High
Composting	High

Much research has been done on how to handle smells and malodors from wastewater treatment utilities due to the close proximity of these facilities to residential areas. The industry has gained considerable experience in identifying and managing fugitive emissions (Brandt and Elliott 2004). While a detailed coverage of all these sources is beyond the present scope, some principles of odor generation can be listed.

General Principles of odor generation from wastewater and food processing plants: Brandt and Elliott 2004; Litchfield 1987; UNIDO).

1. Anaerobic conditions lead to elevated malodor emissions. Such conditions often result from excessive detention times, high strength (i.e. high biological oxygen demand BOD) wastes, high sulfate wastes, and unintended accumulations of solids.

2. Putrescible organics and debris accumulated in lift stations, metering stations, and pretreatment screening devices lead to increased odor emissions if they are not regularly removed.

3. Wastewater turbulence caused by drops, flumes or similar structures lead to increased odor emissions if odorous gases are entrained in the water.

4. High fat, oil, and grease (FOG) content in wastewater can coat the walls of facilities creating increased odors.

5. Low pH wastewater can result in elevated odors from increased hydrogen sulfide emissions.

6. High pH wastewater can result in elevated odors from increased ammonia emissions.

7. Sidestream flows from solids-treatment units such as thickening and digestion are often significant odor sources.

8. Accumulations of scum or other solids on treatment unit walls, weirs, and in troughs can cause increased odor emissions.

9. Treatment lagoons will cause significant odor emissions when aerobic conditions are not maintained. Odors are potentially a problem when any of the following situations occur:
   when water turns over in the spring and fall (for deep ponds)
   when algae die
   during period of excessive organic loading
   when scum accumulates
   when solids removal is inadequate

10. Physical-chemical wastewater treatment is particularly susceptible to odor generation because such systems often do not provide an opportunity for oxidation of sulfides. As a result, hydrogen sulfide emissions can be elevated.

11. All wastewater residuals release odors to some degree. The majority of common odorous compounds are by-products of anaerobic decomposition. Hence, the intensity of fugitive emissions is largely depends on the degree to which aerobic conditions have been and are being maintained.

12. Of all the possible odor sources associated with wastewater treatment, anaerobic digestion represents the most likely cause of complaints. Digester cover gas leaks are responsible for a majority of these emissions.

13. Dewatering facilities can be a major source of odor. Odors are attributable to solids and/or chemical conditioning. Amine-based polymers, commonly used for conditioning prior to dewatering can also contribute to nuisance odors.

Table 3 presents a summary of odorous air treatment technologies for municipal wastewater treatment and biosolids.

Table 3. Odorous air treatment technologies (adapted from WEF 1995).

Technique	Frequency of Use	Cost Factors	Advantages	Disadvantages
Packed-tower wet scrubbers	High	Moderate capital and O&M cost	Effective and reliable; long track record	Spent chemical must be disposed; high chemical consumption; not effective for VOCs
Fine-mist wet scrubbers	Medium	Higher capital cost than packed towers	Lower chemical consumption; can be designed for VOC removal	Water softening required for scrubber water; larger scrubber vessel
Activated carbon adsorbers	High	Cost effectiveness depends on frequency of carbon replacement/regeneration	Simple; few moving parts; effective	Only applicable for relatively dilute air streams in order to ensure long carbon life
Biofilters	Medium	Low capital and O&M costs	Simple; minimal O&M; effective for some VOCs	Effective with a range of odors; requires monitoring for bed moisture; requires periodic media replacement
Thermal oxidizers	Low	Very high capital and O&M (energy) costs	Highly effective for VOCs and odors	Only economical for high-strength, difficult to-treat air streams
Diffusion into activated sludge basins	Low	Economical if existing blowers/diffusers are used	Simple; low O&M; effective	Concern for blower corrosion; may not be appropriate for very strong odors
Odor masking agents	High	Cost dependent on chemical usage	Low capital cost; easy to obtain; good for sporadic odor incidents	Only mask odors; no VOC control

Food Processing

Food processing facilities comprise all operations where the conversion of raw agriculture, aquaculture, and seafood commodities to food products occurs. Food processing includes the slaughtering of poultry and livestock, processing or converting of fish, seafood, milk, meat, eggs, fruits and vegetable crops and other commodities into marketable food items. Malodors are not

normally associated with the actual preparation of food products except for some activities like cooking and drying. Process wastewater treatment at food plants and management of animal manure (at slaughtering facilities) can also generate malodors.

Most emissions arise from the handling, storage and disposal (or recycling) of food processing residuals (FPRs).

Other odor sources at food plants may include uncontrolled refrigeration system ammonia discharges (USEPA 1973) and during regular plant floor and equipment cleaning.

Perhaps more than any other activity at a food plant, management and disposal of sidestream residuals (FPRs) will determine whether there will be odor complaints from neighbors. Due to the nature of commodities being handled, biological decomposition and odor generation will rapidly occur in any materials that are not properly preserved. Any material that does not become a part of the final packaged product must be promptly cycled to some other byproduct, disposed of, or recycled.

Managing Fruit and Vegetable Waste Culls (Solids)

According to Hawkins (2010), the production, harvest, sorting and packing of fruit and vegetables produces close to a billion pounds of produce annually, according to the 2009 agricultural report for Georgia. These processes also result in material that is rotten, has bad spots not noticed in the field, or that is removed from packing lines and not shipped to the consumer.

Fruit and vegetable culls are considered solid waste and while not all of the listed methods of dealing with fruit and vegetable waste material may be applicable for every situation, one of the best methods of dealing with the culls or waste products is to reduce the amount of unusable material brought to the packing house e.g. shelling peas in the field and bringing only the usable product itself back to the processing facility.

There are seven commonly used methods of managing solid fruit and vegetable waste. The list of methods outlined by Hawkins (2010) is:

1. Store culled fruit and vegetables or solid process waste on-site in a pile or bermed area for a limited time (temporary solution). At a minimum, the holding area should be bermed to capture and hold rainfall and any liquids that have formed from the decomposition of the material. If piles are left too long, decomposition may initiate odor generation and if that is the case, storage tanks or bunkers with easy access for removal may be required.

2. Return culled fruit and vegetable waste to the field on which it was grown

3. Feed fruit and vegetable waste to livestock

4. Give the fruit and vegetable culls to local food banks

5. Compost fruit and vegetable culls and solid wastes – again recognizing the odor potential of open air composting piles

6. Process fruit and vegetable culls to separate juice from pulp

7. Dispose of fruit and vegetable waste in local landfill based on local and/or state regulations.

In general, vegetable processing wastes have: large amounts of organic materials such as proteins and carbohydrates, high biochemical oxygen demand (BOD) or chemical oxygen demand (COD) and large amounts of suspended solids. They typically have lower total nitrogen (mg/L) than municipal sewage sludge. In handling these wastes, the primary goals are to separate solids from liquid wastes, recycle as much water as possible and minimize the amount of materials that require special treatment for disposal (Litchfield 1987).

According to the Wisconsin Dept. of Natural Resources, best management practices for handling biodegradable wastes measured by the BOD concentration in wastewater include minimizing spills, completely emptying process and storage equipment prior to washing and sweeping waste from floors instead of washing down the floor drain (WDNR 2009). Solid waste and food by-products should always be managed to optimize opportunities for the best use in the following order: as a raw material for edible products, as animal food, direct land spreading for nutrient utilization, as a compost to produce a soil conditioner, and hauling to a sanitary landfill (WDNR 2009)

In some cases, increasing capital costs have made complex waste treatment too expensive for seasonal plants, especially where these plants produce relatively low volumes of waste or high volume of relatively dilute waste during a short season (Litchfield 1987).

Water Quality Analyses and Odor Control

When assessing the quality of rinse water for land application, it is important to perform the following basic water quality analyses:

Total nitrogen, major nitrogen compounds, and phosphorus
Total organics (measured as BOD, COD)
Suspended solids (measured as TSS total suspended solids)
Salinity (measured as FDS, EC)
Cations and anions,
pH and boron

Alkenols and Alkadienols are extremely important to flavors and fragrances as well as being characteristic aroma constituents for certain natural products (e.g., green grass, mushrooms) raw and particularly cooked. These alkenol compounds are water soluble. For example, peas, cabbage, cauliflower, and Brussels sprouts contain water soluble compounds that have odors described as pungent and fatty (Anon.1). Asparagus has sulfur type fumes caused by methanethiol which smells like rotten eggs and rotting cabbage, has a detection limit in the very low part per billion (ppb) range. Methanithiol is added to natural gas by Utility Companies as a way of detecting natural gas leaks (Daven 2010; Scienceblog 2009). Higgins et al. (2003) found that naturally occurring amino acid (proteins) degradation during anaerobic digestion is the primary contributor to methanethiol or smelly, volatile sulfur compound (VSC) production. These VSCs frequently result in a negative public perception of land applications of wastewater treatment and food processing plant solids (General Chemical 2012).

The most comprehensive odor control measure is to thoroughly stabilize the FPR prior to land application. However, this is rarely possible due to unreasonable expense. The following list

provides general guidance concerning land application and odor control: (Brandt and Martin 2001)

- Keep FPR streams well aerated
- Select land application areas that are distant from neighboring residences
- Avoid spreading when wind is blowing toward populated areas or when nearby neighbors are likely to be engaged in outdoor activities
- Spread in the morning when air is warming and rising rather than in the late afternoon
- Spread on turbulent and breezy days to dissipate and dilute odors
- Avoid spreading near heavily traveled roads and clean up any spills promptly
- Incorporate odorous FPRs into soil immediately
- Liming FPRs can reduce biological activity and odors; however sometimes this only changes the odor and it remains objectionable (Brandt and Martin 2001)

Under typical atmospheric conditions, area source odorants undergo fairly rapid dilution as the distance from the source increases. Odorants will remain most concentrated during periods of high atmospheric stability. The atmosphere is most stable during the night and early morning when wind speed is very low. Once the sun comes up, it warms the soil and dispersion is enhanced.

Drift and odor during land application are affected by several factors. Physical or landscape features, such as windbreaks (trees), can reduce drift and odor (NRCS 2010; Jacobson, et al. 2001; Borrelli et al. 1989). Wastewater properties, such as total solids and pH, can also affect odor. Soil properties such as soil texture can affect odors as well. According to Shaffer and Shah (2008) and USEPA and USDA (2000), application and weather factors that affect drift and odor include:

- droplet size from the land application equipment
- height from ground surface and angle of discharge of wastewater
- discharge pressure of the land application equipment
- nozzle size and type
- weather conditions

Droplet size: As the size of the droplet increases, the potential for drift and odor loss decreases. Application systems that create fine droplets and aerosols create the highest potential for drift and odor movement.

Height of discharge: The height of the wastewater discharge relative to the ground surface has an impact on drift and odor for two reasons. First when wastewater is released higher above the ground or the stream is angled upward, it encounters higher wind speed. In some applications, the maximum height of the wastewater is not the height of discharge because the nozzle is angled up at some degree above the horizontal. Although the higher angles provide greater wetted area coverage, they cause greater drift and odor. Drift and odor (due to release of gases) will be greater because the wastewater stream stays in the air for a longer time due to greater height and angle of discharge.

Discharge pressure: The higher the pressure at discharge, the greater the potential to create smaller droplets.

Nozzle size and type: Droplet size will increase as the pressure is decreased. The nozzle type has a big influence on droplet size; the ring nozzle breaks up the droplets the most, whereas the taper bore nozzle gives the biggest droplets for the same orifice size and operating pressure. The taper ring nozzle is intermediate between the ring and taper bore nozzles in droplet size (Shaffer and Shah 2008).

Weather conditions: Weather conditions that affect drift and odor include wind speed and direction, temperature, relative humidity, and atmospheric stability. These conditions interact in a complicated way with one another and may have opposite effects on drift and odor.

As wind speed increases, drift is increased; however, odor is dissipated faster and does not linger. It is not advisable to spray wastewater when the wind direction can transport drift toward neighbors' houses and streams. Drift increases in warm and dry (low relative humidity) weather because droplets lose moisture while floating downwards, become much smaller in size, and can be transported farther.

Temperature can also increase drift by increasing turbulence in the lower atmosphere; however, its impact on odor is complicated. Although warm temperatures increase the activity of odor-causing bacteria, land application in warm weather will result in faster dissipation of odor due to greater turbulence. Increased relative humidity increases the perception of odor.

The atmosphere is stable when the air close to the ground is colder and heavier than the air above it. This usually happens during early morning hours when winds are low. Land application under stable conditions will result in odors being trapped close to the earth and spread sideways, causing complaints from neighbors. However, drift is minimized under such conditions due to low wind, cool temperature, and high relative humidity. As the sun heats the ground, the warmed air rises upward, pulling down the relatively cooler air and creating unstable conditions. Unstable conditions may cause more drift, but less odor because of better dissipation of gases (Shaffer and Shah 2008). It is clear that environmental conditions can affect drift and odor in different ways, making management difficult. There is a tradeoff between drift and odor. It is generally recommended that spray application of wastewater should be done under low wind (less than 5 mph) and after mid-morning, preferably in bright sunshine (Shaffer and Shah 2008).

The need for odor and drift control may require a field-by-field decision because it is related to the area where wastewater application occurs.

Tables 4a and 4b show the most commonly used types of wastewater application equipment with definitions and the relative potential for drift and odor during application.

Table 4a. Most commonly used types of wastewater application equipment with simple definitions and relative potential for drift and odor (Shaffer and Shah 2008).

Equipment Type	Description	Relative Potential for Drift	Relative Potential for Odor
Big gun	A sprinkler with a large bore opening, ranging from 0.5 to 2.0 inch diameter. Typical operating pressure is 40-80 pounds per square inch (psi)		
Stationary	Typical height above ground surface is 4-6 feet	High	High
Traveling	Typical height above ground surface is 4-6 feet		
Center pivot/linear move	Typical height above ground surface is 10-12 feet		
Impact Sprinkler	A sprinkler with a small bore opening, generally from 1/8 to 3/8 inch diameter. Typical operating pressure is 25-60 psi	Moderately high to high (height dependent)	High
Stationary	Typical height above ground surface is 1.5-5 feet		
Center pivot/linear move	Typical height above ground surface is 10-12 feet		
Drop nozzle	A nozzle typically attached to a drop hose and pressure regulator to allow water discharge at a height just above or just below the crop canopy. Typical operating pressure is 15-30 psi	Low to Moderate	Low
Center pivot/linear move	Typical height above ground surface is 3-6 feet		
Boom sprayer	Typical height above ground surface is 2-4 feet		
Low drift drop nozzle	A specialized drop nozzle designed to create a stream of water and minimize the fine droplets that are prone to drift. Typical operating pressure is 5-20 psi	Very low	Very low
Center pivot/linear move	Typical height above ground surface is 3-6 feet		
Hosedrag sprayer	Typical height above ground surface is 2-4 feet		
Large diameter, low pressure discharge hose	A device or opening designed for a large volume discharge at a very low pressure (less than 5 psi). These nozzles are typically 2 inches and larger, with a swath width usually less than 10 feet.	Very low	Very low
Boom sprayer	Typical height above ground surface is 1-3 ft. feet		
Hosedrag sprayer	Typical height above ground surface is 1-3 feet		
Tanker wagon	These are liquid tankers that also use a large diameter, low pressure nozzle for water distribution. Typical operating pressure is less than 10 psi.	Very low to low (height dependent)	Low
Broadcast	Typical height above ground surface is 3-10 feet	----------	----------
----------	----------	Very low to	Very low
Injected		none	
Drip emitter	This is a specially designed tubing that discharges very low volumes of wastewater at low pressure. While internal operating pressures within the tubing may be high, discharge pressure is very low		
at ground surface		Very low to none	Very low
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below ground		None	None

Table 4b. Factors for selection and operation of various types of wastewater application equipment (Shafer and Shah 2008).

System Type	Relative Cost	Operational demands	Applicability to site	Maintenance Requirements	Comments
Stationary big gun	Moderate	Low	Not suited to small fields or fields with slow infiltration rates	Moderate	
Small impact sprinkler	Moderate	Low	Suited to medium to large fields. Not suited to moderately sloping or irregularly shaped land	Moderate	Smaller nozzles clog readily with wastewater solids.
Traveling gun unit	Moderate (A tractor is assumed to be available)	Moderate	Suited to medium to large fields. Not suited to moderately sloping or irregular shaped land	Moderate	Mobile, easy to add additional acres
Center pivot and linear move systems	High	Low	Suited to large fields only. Not suited to moderately sloping or irregularly shaped land	Moderate	Per acre cost decreases as field size increases. Small nozzles are prone to clogging with wastewater constituents.
Boom sprayers	Moderate	High	Not suited to moderately sloping or dissected land	Moderate	Typically used in buffer or problem areas. Not practical to move frequently to cover large areas. Small nozzles are prone to clogging with wastewater constituents.
Hosedrag systems	Moderate	High requires full time operator	Applicable to a wide range of conditions. Possibly suitable for areas that cannot be covered by irrigation systems.	High-unit plus tractor	Relative cost does not include tractor, assumes one of adequate size available
Tanker wagon system	High	High requires full time operator	Applicable to a wide range of conditions. Possibly suitable for areas that cannot be covered by irrigation systems.	High-unit plus tractor	Cost figure does not include tractor, assumes one of adequate size available
Drip irrigation	Very high	Very high	Suited for small fields and small flows	High	Could be used in buffers/sensitive areas in conjunction with other systems. Wastewater must have very low suspended solids.

Incorporation measures may have limited value because most irrigated wastewater will soak into the soil and usually not result in persistent residual odor. In taller vegetation, odor may persist longer than on bare soil because as the liquid intercepted by the vegetation evaporates; odorous gases are released (Shaffer and Shah 2008).

There is strong evidence to support that trees do improve 1) air quality and 2) water. They also have the potential to be economically feasible to most livestock producers. Cost will vary from site to site along with different species of trees and shrubs that will be used, and the specific design of each windbreak. Poplar species seem to be a common element in both odor dispersion and buffering of wastewater runoff. Poplar are fast growing species that can serve as nursery trees to the longer-living slower growing species in each windbreak. Density or porosity of a particular shelterbelt seems to be a very significant element in dispersion and turbulence, but there is no clear way to measure the most beneficial spacing throughout a shelterbelt. Research on particular species being more beneficial for odor removal or wastewater uptake seems to be lacking (Hernandez et al. 2012; Griffith 2001; Borrelli et al.1989).

Table 5 Summary of Odorous Air Treatment Strategies for Livestock and Poultry Building Sources (adapted from Jacobson, Bicudo, and Schmidt 2001): BEST PRACTICES

Process/System		**Description**	**Advantages**	**Disadvantages**
Exhaust Air Treatment	Biofilters	Odorous gases are passed through a bed of compost and wood chips; bacterial and fungal activity help oxidize volatile organic compounds	Effectively reduces odors and hydrogen sulfide emissions	May need special fans because of pressure drop. Rodent control is important
Dust Reduction	Windbreak walls	Many odorous compounds are adsorbed on dust particles and conveyed on dust. A wall made of tarp or any other porous material is placed 10-15 ft. from exhaust fans. The walls block some of the fan airflow in the horizontal direction. Dust and odor levels downwind of windbreaks may be lower since the plume is deflected.	May effectively reduce dust and odor emissions is necessary for sustained odor control	Periodic cleaning of dust on walls
	Shelterbelts	Rows of trees and other vegetation are planted around a building, creating a barrier for both dust and odorous compound removal from building exhaust air. Trees absorb odorous compounds and create turbulence to disperse odors upwards.	May effectively reduce dust and odor emissions	It may take several years to grow an effective vegetative windbreak
	Washing Walls	A wetted pad evaporative cooling system is installed in a stud wall about 5 ft. upwind of ventilation fans and downwind of hogs in a tunnel-ventilated building.	At medium ventilation rate, reduces about 50% of dust and 33% of ammonia	Residence time inside the pad is very small; thus odor removal may not be highly effective.
	Oil sprinkling	Vegetable oil is sprinkled daily at low levels in the animal pens	Helps reduce airborne dust and odors	Requires more time and effort to between animals
Diet Manipulation	Synthetic amino-acids and low crude protein	Products are mixed into the feed	Lower N content in the manure, may reduce odor and ammonia	Not known yet

	content		emissions	
	Feed additives (Yucca schidigera)	Product is mixed into the feed	May reduce odor and ammonia emissions	Not know yet
Bedding		Dry carbon source added to animal pens to promote comfort and soak up manure	Reduced obnoxious odors, works for all species	Must harvest or buy bedding and add it throughout the year, increased volume of manure to haul
Manure Additives		Chemical or biological products are added to the manure	May reduce odor and ammonia emissions	Usually questionable products, may not achieve desirable results under field conditions

Table 6. Suggested list of Odor Control Best Practices and Technologies in Food Industry 'Post-Processing', modified from NRCS 2010[1], Sheffield et al. 2008[2], Shaffer and Shah 2008[3], Brown and Caldwell 2007[4], Jacobson et al. 2001[5], Brandt and Martin 2001[6], Eckenfelder et al[7], EnvironOzone[8], Burgard[9], Francisco[10], Beach[11], Satterfield[12], Wang[13]

Application	Location	Technology	Type of Practice	Mode of Practice	Description	Status
Emissions Capture	Storage Basin/Lagoon	Impermeable cover	T	F,I	HDPE or similar cover. May reduce aeration success[2]	P
	Storage Basin/Lagoon	Geotextile permeable cover	T	F,I	Geotextile cover to reduce odors, VOCs and H_2S[2]	P
	Storage Basin/Lagoon	Granular foam biocover	T	F,I	Permeable biocover to reduce odor, NH_3, VOCs, and H_2S[2]	P
	Storage Basin/Lagoon	Fixed foam & geotextile cover	T	F, I	Permeable biocover to reduce odor, NH_3, VOCs, and H_2S[2]	P
	Storage Basin/Lagoon	Straw biocover	T	F, I	Barley and wheat straw biocovers for winter storage[2]	IS
	Outdoor solid residual/rejected raw material stockpiles	Permeable synthetic or organic biocover	M	F, I	Gor-Tex like cover to reduce odor; truck off-site for animal feed[2]	D
FPR collection and treatment	FPR solids removal (separation systems, line flushing)	Mechanical screens (static/dynamic), centrifuge, gravity settling, flotation, and micro-nano or ultra filtration.	T	F, I	Screening is the least expensive form and should be used to the maximum extent.[3,9,10,11] Removing solids in the process/rinse water may provide a reduction in the BOD load/odor. Reduces plugging of distribution nozzles and valves and eliminates solids build-up on irrigated land to minimize odors.[2,9,12] Removal frequencyvolume is	D

					important[9,12].	
		Pipeline maintenance	M	F, I, O	Flush pipe/distribution equipment at the end of season with high pressure fresh water to eliminate solids putrification, anaerobic conditions and odor on start up. Removal and flush volume are important[2,9] Scouring velocity in pipes should be high with pigging of the lines at appropriate internals if flows are discontinuous[9,12]	D
FPR collection and treatment	Storage basin/lagoon	Anaerobic digestion	T, M	F, I, O	Anaerobic treatment and storage lagoon to reduce odors, BOD and TSS. Uncovered anaerobic lagoons may produce odors due to large surface area[2]	
	Storage basin/lagoon	Aerobic digestion	T, M	F, I, O	Aerobic digestion and pond aeration produces relatively odor free liquid[9,10,11] Electrical costs of aeration must be considered[2,6] Mix fresh with stored water[10]	D
	Storage basin/lagoon	Odor control chemicals/masking agents, odor counteractants, odor absorption chemicals and enzymatic biological inhibitors			Little data available concerning chemical control effectiveness[6,10] Are expensive, not well suited to odors that are comprised of complex compounds. Ozone generators have been used successfully on CAFOs, in specific buildings, has potential human health issues if not tightly controlled; Requires experienced technicians[8]	T
	Storage basin/lagoon effluent	pH adjustment	M	I, O	6.5 to 7.5 optimum for anaerobic bacteria 6.5-8.5 optimum for aerobic processes[7]	
	Irrigation	Low-pressure application	T,M	I	Use low pressure drop nozzles with rotating sprinklers that encourage large droplet production.[2,6,9,13] Ring	D

Land Application					nozzles break up droplets the most, taper bore nozzles gives the biggest droplets for the same orifice size and operating pressure[3]	
	Irrigation	End-gun prohibition	M	I,F	Cease use of center pivot end-guns[2]	D
Land Application	Irrigation	'Dribble' drop hoses	T, M	I	Use low pressure drop hoses with dribble nozzles to apply high volumes directly to soil surface. Must consider application uniformity.[2] Decrease angle of discharge because higher angles provide greater wetted area coverage, but cause greater drift and odor due to release of gases lingering in the air longer[3]	D
	Irrigation	Inner-canopy applications	M	I	Extended low pressure drop hoses used when crop growth is above sprinkler. Must consider lower application uniformity and high precipitation rates.[2]	D
	Irrigation	Pre-application aeration/oxidation	T, M	I,D,F,O	Aeration of stored effluent prior to application. Oxidize odorants and VOCs, Increase ORP. [2]	
	Irrigation	Timing	T, M	F, I, D, O	Irrigate from storage reservoirs as soon as possible to avoid anaerobic conditions/odors[2,6,10,11]	D
	Irrigation	Weather – wind speed/direction	M	D, I	As wind speed increases, drift is increased, however odor is dissipated faster and does not linger. Do not spray wastewater when wind direction can transport drift toward neighbors' houses. Drift increases in warm and dry (low relative humidity) conditions[3,6,10,11]	D
		Weather – temperature	M	D, I	Land application in warm weather will result in faster dissipation of odor due to greater turbulence.	

Land Application	Irrigation				Increased relative humidity increases the perception of odor[2]	
		Weather – atmospheric stability (odor drift versus duration)	M	D, I	Atmosphere is stable when the air close to the ground is colder and heavier than the air above it. This usually happens during early morning hours when winds are low. Odor is trapped close to the ground causing complaints from neighbors. Drift is minimized under such conditions. It is recommended that spray application of wastewater be done under low wind (less than 5 mph) and after mid-morning, in bright sunshine.[3] Other authors say to spray on turbulent and breezy days to dissipate and dilute odors[6]	
	Irrigation	Control/Placement	M	D, I	Avoid spreading near heavily traveled roads and clean up any spills promptly[6]	
	Irrigation	Control/Placement	M	D, I	Avoid property boundaries, use buffer zones and set backs[1,6]	
	Irrigation	Incorporation	M	D	Has limited value because most irrigated wastewater will soak into the soil and usually not result in persistent residual odor.[3]	
	Irrigation	Incorporation	M	D	Reduce soil surface standing water if FPR is high intensity[3]	
	Irrigation	Crop selection	M	D	Select crop for height considerations. On taller vegetation, odor may persist longer than on bare soil because as the liquid intercepted by the vegetation evaporates; odorous gases are released[3]	
Dispersion (wind/turbulence)	Property	Natural windbreaks;	T	I	Plant fast growing trees to break wind flow and vertical aerial mixing.	D

	Boundaries	shelterbelts			Increases aesthetics. Will require irrigation and several years to be effective as windbreak.[1,5,10,13]	

Acronyms used in Table 6

BOD – Biochemical oxygen demand
C: N – Carbon to nitrogen ratio
H_2S – Hydrogen sulfide
HDPE – High density polyethylene
NH_3 – Ammonia
OMP – Odor Management Plan
ORP – Oxidation reduction potential
MC- Moisture content
TSS – Total suspended solids
VOC – Volatile organic compounds
VFA – Volatile fatty acids
FPR – Food Processing Residuals

Type of Practice: T= Technology M=Management
Mode of Practice: I=Intensity, D=Duration, F=Frequency, O=Offensiveness

Status: IS=Installed on dairy or swine farms, D=Done, P=Possible, T=Theoretical, not tested

APPENDIX A

Redwine and Lacey 2000

From Redwine and Lacey 2000

Table 1 – Summary of state odor regulations

State	*Odor*	*Setbacks*	*Permits*	*Public*	*Training*	*LA*	*Other*	*Citations*
AL	No	Yes 330-1320 ft	Annual Registration	No	Yes	Yes	Must develop and file a Waste Management Plan to obtain registration	Alabama Department of Environmental Management Rules Chapter 335-6-7 (4/1/1999)
AR	No	Yes 50-1320 ft	Yes If using liquid waste management systems General, individual or National Pollutant Discharge Elimination System (NPDES)	Yes	Waste management and odor control training	Yes	Permittees are encouraged to adopt "good neighbor" policy to minimize odor Permitted facilities must prepare waste management and site management plans	Arkansas Pollution Control and Ecology Commission Regulation No. 5 (2/23/2000) APC&E Commission Regulation No. 18, Appendix A (1/22/1999)
AZ	No	No	Yes General	No	No	No	Must comply with BMPs to obtain permit Inspections conducted, odor on checklist Protected from nuisance suits	Arizona Administrative Code R18-9-203 (1/4/1991) Arizona Revised Statutes 49-247 ARS 3-112
CA	No	No	Yes 1 of 2 permits	No	No	No		California Air Pollution Control Laws, Health and Safety Code 41705
CO	Yes[1]	Yes 100 ft-1 mi. (Swine only)	Yes (Swine only)	Yes	No	Yes (Swine only)	Must have odor management plan and employ odor control technologies to obtain permit All anaerobic lagoons must be covered (swine only)	Colorado Air Quality Control Commission Regulation No. 2 (3/30/1999)
DE	No	Yes 100-200 ft	State NPDES permit in development		Yes	No	Must file a nutrient management plan to obtain permit	Delaware Code Title 3 Chapter 22 (1999)
FL	No	No	Yes Dairy farms in Lake Okeechobee Basin, CAFOs that discharge, and egg production facilities	No	No	Yes	None	Department of Environmental Protection Rule 62-670 (12/26/96)

State	Odor	Setbacks	Permits	Public	Training	LA	Other	Citations
GA	No	Yes 50-1750 ft	Yes Swine only Permit by rule or permit	Yes	Yes (Rule to be developed by 1/31/2000)	No	Applies to swine operations only	Rules and Regulations for Water Quality Control Chapter 391-3-6 (7/6/1999)
IA	No	Yes 750-2500 ft	Yes Construction Permit	Yes	To land apply wastes	Yes	Manure management plan required	Iowa Administrative Code 567-65 (Revised 1999)
ID	No	No	Swine and poultry operations must obtain permit Dairy waste systems must be approved	Yes	No	No	Permit may require an odor management plan	Idaho Administrative Procedures and Acts 16.01.09 (11/19/99) IDAPA 01.04.14 (9/1/99)
IL	No	Yes 0.25-1 mi.	New lagoons must be registered	Yes	Yes	Yes	Specific odor control measures for lagoons outlined	Illinois Compiled Statues Livestock Management Facilities Act, 510 ILCS 77 (5/21/96) Illinois Administrative Code Title 35, Subtitle E, Chapter I, Part 506 (11/12/98)
IN	No	No	Must gain approval to construct or expand	No	No	No	Manure management plan required New rules have been drafted	Indiana Code 13-18-10 (1997)
KS	No	Yes 1,320-16,000 ft	Yes Permit or registration	Yes	Yes (Swine only)	Yes	Manure management plan, nutrient management plan, and odor management plan may be required. Vegetative screening may be required for odor control.	Kansas Administrative Regulation Article 16, Article 18, and Article 29 (9/26/1997)
KY	No	Yes 50-3000 ft	Yes 1 of 3 permits	Yes	No	Yes	Resolution passed October 20, 1999 to develop CAFO State Action Plan	401 Kentucky Administrative Rules 5 (11-19-1998)
LA	Yes[ll]	No	Yes	No	No	No	None	Louisiana Administrative Code 33:III.Chapter 29 (6/6/1997) 33:IX.Chapter 23 (8/24/1999)
MD	No	No	Yes General permit	No	No	No	None	Code of Maryland Regulations 26.08.01 through 26.08.04
ME	No	No	Yes 1 of 3 permits	Yes	No	No	Large CAFOs must use Best Available Management Practices to control odor	Maine Revised Statutes Title 7, Chapter 747 (5/1/1999)

State	Odor	Setbacks	Permits	Public	Training	LA	Other	Citations
MI	No	No	Yes	Yes	No	No	None	Michigan Administrative Code R 323.2101- 323.2192 (11/13/1992)
MN	No	No	Yes Certificate or permit	No	No	No	Hydrogen Sulfide Ambient Air Standard (30 ppb or 50 ppb at property line) New feedlot rules proposed	Minnesota Rules, Chapter 7020 (11/03/1998), Chapter 7009 (1983) Minnesota Statutes Chapter 116.0713 (1997)
MO	Yes[iii]	Yes 1000-3000 ft	Yes	Yes	Yes	No	7000 AU and over must file extensive odor control plan and implement odor control measures	10 Code of State Regulations 10-2.070 (7/30/1999) 10 CSR 10-3.090 (7/30/1999) 10 CSR 10-4.070 (7/30/1999) 10 CSR 10-5.160 (7/30/1999) 10 CSR 20-6.300 (3/30/1999) 10 CSR 20-14 (11/30/1996) Missouri Revised Statutes 640.710 (6-25-96)
MS	No	No	Yes Worksheet or permit	No	No	No	None	Mississippi Code 49-17-29 (06/01/1998)
MT	No	No	Yes General permit	Yes	No	No	None	Montana Code Annotated 75-5 (1997)
NC	No	Yes 75-5000 ft	Yes	No	No	Yes	May have to file best management plan that includes odor abatement plan if meet size and citing requirements and use liquid waste system Permit includes animal waste management plan that must contain BMPs to minimize odor	15A North Carolina Administrative Code 2D.1800 (7/1/2000) North Carolina General Statutes 143-215.10A-G (1995)
ND	Yes[iv]	No	May have to have approval to operate	No	No	Yes	Hydrogen Sulfide Standard (50 ppb)	North Dakota Administrative Code 33-15-16 (6/1/1990) NDAC 33-16-03
NE	No	Yes 1000 ft	Yes	Yes	No	Yes	Permit requires BMP for odor control All feedlots 300 AU and over without a permit must be inspected	Nebraska Administrative Code Title 130 (7/10/1995, Proposed revisions not yet passed)

State	Odor	Setbacks	Permits	Public	Training	LA	Other	Citations
NH	No	Yes 100-500 ft	No	No	No	No	Odor defined as air pollutant, agricultural practices loosely protected from nuisance suits	40 RSA 432:32-35 (7/1/1985) 64 RSA 674:26 (1/1/1984) 10 RSA 125-I:2 (1/7/1987)
NV	Yes[v]	No	Yes	Yes	No	No	None	Nevada Administrative Code 445B.393 (10/30/95) 445A.070 - 445A.348
NY	No	No	Yes General or individual	No	No	No	Odor is air pollutant Must file waste management plan for permit	6 New York Codes, Rules, and Regulations Part 200 6 NYCRR Chapter 10-A, Article 3 (7/1/1999)
OH	No	No	Yes	No	No	No	Must have approval of manure management plan	Ohio Administrative Code 1501:15-5 (11-15-94)
OK	No	Yes Swine and poultry 0.25-3 mi.	Construction permit (swine and poultry) or registration (poultry only)	Yes	Odor control education Poultry operators must be certified	No	Must file odor control plan for permit (swine and poultry only) Odor emission indirectly defined as air pollution	Oklahoma Administrative Code 35:17-3 (8/1/1998) OAC 35:17-5 (7/1/1998)
OR	No	No	Yes	No	No	No	None	Oregon Administrative Rules 603-074 (7/26/1994) OAR 340-051 (2/15/1972)
PA	No	Yes 100-200ft	No	No	No	No	Must file nutrient management plan	25 Pennsylvania Code 123.31 (9/10/1971) 25 PA Code 92 (7/21/1984) Nutrient Management Act (10/1/1997)
RI	Yes[vi]	No	No	No	No	No	None	Department of Environmental Management Air Pollution Regulation 17 (2/22/1977)
SC	Yes[vii]	Yes 50-1,750 ft	Yes	Yes	Yes	No	Waste management plan that includes odor abatement plan must be implemented Lagoons must be no larger than 4 acres (swine only)	South Carolina Code of Regulations 61-43 (6/26/1998)

State	Odor	Setbacks	Permits	Public	Training	LA	Other	Citations
SD	No	No	Yes General permits	Yes	Yes	Yes	Best Management Practices Requirements Annual inspections (2000 AU and over) Odor is an air contaminant	Administrative Rules of South Dakota 74:50 (2/10/1998) ARSD 74:36 (12/21/1981) ARSD 74:52 (2/1/1997) ARSD 74:57 (2/1/1998)
TN	No	No	Yes General	No	No	No	None	Rules of the Tennessee Department of Environment and Conservation Chapter 1200-4-10 (5/1/1999)
TX	No	Yes 0.25-0.5 miles	Yes Air and water (both or combined)	Yes	Yes	Yes	Subject to Hydrogen Sulfide Standard Odor is an air contaminant	Texas Natural Resource Conservation Commission Rules §321.31-321.47 (7/27/1999) TNRCC Rules §321.181-321.198 (7/13/1999) TNRCC Rules Chapter 116 (9/23/1999) 30 Texas Administrative Code Sec. 112.31-32 (1/11976)
UT	No	Yes 0.25 miles	Yes Permit by rule or permit	No	No	No	Odor control technical requirements must be met	Utah Administrative Code Rule R317-6 (1990)
VA	No	Yes 200 ft	Yes General or individual	Yes	Yes	No	None	9 Virginia Administrative Code 25-31-130 (5/27/98) 9 VAC 25-192-10 through 25-192-70 (12/1/1998)
VT	Yes[viii]	No	Yes	Yes	No	Yes	None	VT Air Pollution Control Regulations 5-241 (1/25/1978) VT Accepted Agriculture Practice Regulations (6/29/1995) VT Best Management Practices Regulations (1/27/1996) VT Large Farm Operations Regulations (11/23/1999)

State	Odor	Setbacks	Permits	Public	Training	LA	Other	Citations
WA	Yes[ix]	No	Yes Registration or permit	No	No	No	Cannot mask odor emissions Inspection program	Revised Code of Washington Chapter 90.64 (4/1/1998) Washington Administrative Code 173-400-030 (9/20/93) WAC 173-220 (9/22/93)
WI	No	No	Yes	No	No	No	Odor is an air contaminant	Wisconsin Administrative Code NR 243 (8/1/1997) Wisconsin Statutes 285.01
WV	No	No	Yes	Yes	No	No	None	
WY	Yes[x]	Yes Swine only 0.25-1 mile	Yes Swine only	Yes	No	Yes	Must implement waste management plan that include odor control to obtain permit	Wyoming Water Quality Division Rules Chapter 20 (5/26/1999) Wyoming Air Quality Standards and Regulations Chapter 2 (10/15/1998)

[i] Colorado odor standard
Residential or commercial areas – 7 DT; All other areas – 15 DT
Housed Commercial Swine Feeding Operations
7 DT at property line; 2 DT at any off-site occupied dwelling or curtilage, public or private school, place of business, or the boundaries of any incorporated municipality

[ii] Louisiana odor standard
Ambient air standard-Less than or equal to 6 on an eight point butanol scale measured with a Butanol Olfactometer; Agriculture related operations have a loose exemption

[iii] Missouri CAFO Odor Rule
Effective Jan 1, 2002, applies to Class 1A (7000 AU or more) only; 4 DT measured with a Scentometer or by a similar technique

[iv] North Dakota Odor Standard
No discharge of odor in excess of two odor concentration units outside the property line, measured with Barnebey-Cheney Scentometer or other approved method

[v] Nevada Odor Rule
No discharge of odor over 8 DT; Odor source investigated when 30 percent or more of a sample of the people exposed to it believe it to be objectionable in usual places of occupancy.

[vi] Rhode Island
No emission of substance that causes an objectionable odor beyond property line

[vii] South Carolina
No producer may cause, allow or permit emission of an undesirable odor into the ambient air unless preventive measures to abate/control the odor are utilized

[viii] Vermont
Prohibition of emission of objectionable odors beyond the property line

[ix] Washington
Any person that allows the emission of an odor must use recognized good practices to minimize the odors; Masking is not allowed

[x] Wyoming
7 DT at property line measured with a Scentometer

APPENDIX B

Jacobson, Moon, Bicudo, et al. GEIS 1999
University of Minnesota

A summary of odor regulations (compiled by the Attorney General of the State of North Dakota 1999**).**

STATE	ODOR REG. YES/NO	LEVEL	METHOD	WEBSITE
Arizona	Yes (Water)	Arizona has a rule that restricts "odor in drinking water." Arizona does not have a specific rule or statute restricting odor in the air other than their general pollution and nuisance laws. AZAC § R18-11-108(A)(3)		http://www.adeq.state.az.us/air/assess/index.htm
Colorado	Yes	AQCC Reg. 2 - Residential or commercial - viol. If odors are detected after the air has been diluted with 7 or more volumes of odor free air. All other land use areas - 15 or more vols. EXCEPT- if source is mfg. or agricultural operation, no viol. if "best practical control methods" are used. Exception doesn't apply if, after air has been diluted with 127 or more vols. of odor free air and odors are detected.	Barnebey-Cheney Scentometer or any other instrument, device or technique.	http://www.state.co.us/gov_dir/cdphe_dir/ap/aphom.html
Connecticut	Yes	No person shall cause or permit the emission of any substance or combination of substances which creates or contributes to an odor, in the ambient air, that constitutes a nuisance. § 22a-174-23(a). It constitutes a nuisance if a rep. of the comm. or at least 50% of any group of reps. of the comm. determines, based upon at least 3 samples or observations in a 1 hour period, that after a dilution of 7 parts clean air to 1 part sampled air, the odor is equal to or greater than the odor detection threshold. The owner or operator of the source of the burden to rebut the presumption of a nuisance. § 22a-174-23(b). A table sets out the concentration levels. § 22a-173-23(c). The comm. may reasonable suspect that a source has caused or contributed to a violation based upon 1 or more of the following: 1) citizen complaints; 2) comparisons of odors upwind and downwind of the source; 3) material handling and storage practices; 4) methods of operation; 5) site inspections; 6) surveys; 7) info. gathered from any other source; or 8) actual or estimated stack emissions, fugitive emissions or ambient pollutant concentrations. § 22a-174-23(e). An agr. or farming operation shall be exempt to the extent provided by §19a-341. § 22a-174-23(j). The provisions of this section shall not apply to mobile sources or structures which are occupied solely as a dwelling and contain six or fewer dwelling units. § 22a-174-23(k).	Comm. may use air quality modeling tech. To calculate ambient pollutant concentrations. It cannot be the sole basis for finding a violation unless the comm. has received 10 or more written complaints. §22a-174-23(f).	http://dep.state.ct.us/lawreg/lawhome.htm
Delaware	Yes	Reg. 19 - No limit, just "significantly effect the citizens...outside the boundaries of the air contaminant source."	Scentometer, air quality monitoring and affidavits	http://www.dnrec.state.de.us/
Florida	Yes	62-296.320(2) - No person shall cause, suffer, allow or permit the discharge of air pollutants which cause or contribute to an objectionable odor.		http://www.dep.state.fl.us/ogc/documents/rules/air/62-296.doc
Kentucky	Yes	Secondary standard for odor shall be applicable only when the cabinet receives a complaint with respect to odors from a source. 401 KAR 53:005 § 2(2). Odor means the property of an air contaminant that can be detered by the sense of smell. § 3(12). The ambient air quality standards are listed on Appendix A to 401 KAR 53:010.		http//www.state.ky.us/directory/agencyn.htm
Louisiana	Yes	Title 33, Part III, Ch. 29 § 2901(A) establishes ambient air standards for odors. There	Odor test methods: 1)	http://www.deq.state.la.

STATE	ODOR REO. YESIN O	LEVEL	METHOD	WEBSITE
		is an "odor dilution ratio" and "perceived odor intensity" is the intensity of an odor sensation that is independent of the knowledge of the odorant concentration. § 2901(c). Exemptions are provided for I) single family dwellings; 2) restaurants; 3) other establishments for the purpose of preparing food for human consumption; 4) materials odorized for safety purposes; 5) materials possessing strong odors for reasons of public health and welfare where not suitable substitute is available and where best modern practices are employed; 6) agricultural, fiber, timber, poultry, seafood or fisheries production, unless such odors are detected in concentrations or intensities above that normally detected from these processes or by products when using applicable air pollution control devices; and 7) emission points regulated under the Total Reduced Sulfur (TRS) emission standard. § 2901(E).	Butanol odor evaluation procedure; 2) Butanol referencing techniques for quantifying odors in terms of intensity; 3) ProblemslBacktlows. (All of the above are described in technical detail at § 2901(0»	us/olae/irddltitle33/p03c2901.pdf
Maine	Yes	06·096(4) provides for adequate provisions for the control ofodors under the solid waste laws. The board may establish terms or conditions of approval, reasonable requirements to control odors.		http//www.state.me.us/dep/mdep_reg.htm
Maryland	Yes	A person may not cause or permit the discharge into the atmosphere of gases, vapors, or odors beyond the property line in such a manner that a nuisance or air pollution is created. § 26.11.06.09. Also use nuisance section at 26.11.06.08		http://www.dnr.state.md.us/
Massachusett s	Yes	No person having control of any dust or odor generating operations ... shall permit emissions therefrom which cause or contribute to a condition of air pollution. 310 CMR § 7.09. Air pollution means the presence in the ambient air space of one or more air contaminants or combinations thereof in such concentrations and of such duration as to: a) cause a nuisance; b) be injurious, or be on the basis of current information, potentially injurious to human or animal life, to vegetation, or to property; or c) unreasonably interfere with the comfortable enjoyment of life and property or the conduct ofbusiness. 310 CMR § 7.00.		http://www.magnet.state.ma.us/dep/dephome.h 1m
Michigan	Yes	Odor is included in the definition of "air contaminant." Emissions of air contaminants are prohibited if the cause either of the following: a) Injurious effect to human health or safety, animallifu, plant life of significant economic value, or property. b) Unreasonable interference with the comfortable enjoyment oflife and property. Pt.9, R.336. 1901. Rule 901.	No rule concerning the method and just use general reasonableness, frequency. duration, intensity etc.An old court case lists some of these.	http://www.deq.state.mi .us/aqdl
Minnesota	Yes	While they do not have a general restriction on odors (this is left up to the locals), Minnesota does have a state statute, § 116.061(1)(a)(3), which requires notification of excessive emissions that cause obnoxious odors constituting a public nuisance. Also, in their ambient air quality standards, they limit Hydrogen Sulfide to 0.05 ppm by volume (70.0 micrograms per cubic meter); 112 hour average not to be exceeded over 2 times per year. See Rule 7009.0080.		http://www.dnr.state.mn.us*l*
Mississippi	Yes	Rendering plants or other similar operations which may cause odors must be at least 1500 feet from the nearest residential, recreational, or light commercial area and be	Factors to consider include: I) the number of	http://www.deq.state.ms.us/domino/deqweb.ns

STATE	ODOR REG. YESfNO	LEVEL	METHOD	WEBSITE
		located in compliance with Miss. Code Ann. §41-51-19. APC-S-2(15). There shall be no odorous substances in the ambient air in concentrations sufficient to adversely and unreasonable: 1) affect human health and well being; 2) interfere with the use or enjoyment of property; or 3) affect plant or animal life. APC-S-4.	complaints or petitioners; 2) the lrequency of occurrence: and 3) the land use of the affected area.	f
Missouri	Yes	10CSR 10-2.070 restricts emissions ofodors when the odor can be perceived when I volume ofodorous air is diluted with 7 volumes ofodor-free air for 2 separate trials not less than 15 minutes apart within the period of 1 hour. Missouri actually has four separate standards which are closely related to the above. See attached. One for Kansas City metro area, Springfield, Greene County and St. Louis metro area. 10-5.160 provides a separate standard for objectionable odors when 30% or more ofa sample of the people exposed to it believe it to be objectionable in usual places of occupancy, the sample size to be at least 20 people or 75% ofthose exposed iffewer than 20 people are exposed. The agricultural exemption still applies to this section. See 10.5-160(2). 10 CSR 10-2.070(3) provides an exception for odors from the raising and harvesting of crops or feeding, breeding and management oflivestock or domestic animals or fowl (Class lA CAFOs). However, the commission will vote next month on whether to take out the agriculture exemption. See the attached proposed amendment (which may be subject to change prior to the vote).	Bamebey-Cheney Scentometer or by similar technique that will give equivalent results. as agreed to at the source operator and the staff director.	
Montana	Yes	No person shall cause, suffer, or allow any emissions ofgases, vapors, or odors beyond his property line in such a manner as to create a public nuisance. § 17.8.315. Also limits business and equipment operation, storage, gases, dust and incineration among others as to odors. ,W. Waste generating noxious odors may not be open burned. § 17.8.604.		http://www.deq.state.mt .us!
Nebraska	Yes	No specific odor reg. as such, but have total reduced sulfur (TRS) regs. and H2S like MN. TRS 10.0 parts per million (10.0 ppm) maximum I minute average concentration. 0.10 parts per million (0.10 ppm) maximum 30-minute rolling average. See Title 129, Ch. 4 §§ 007 et seq. Neb. said they did have an agr. exemption, got sued (because Iowa Beef said they were discriminated against). The Iowa case was decided and Neb. then took out the ago exemption and the suit was dropped about 2 weeks ago.	TRS thermal converter in conjunction with an S02 monitor.	http://www.dcq.state.ne .us!
Nevada	Yes	No person may discharge or cause to be discharged from any stationary source. any material or regulated air pollutant which is or tends to be offensive to the senses, injurious or detrimental to health and safety, or which in any way interferes with or prevents the comfortable enjoyment of life or property. NAC 445B.393(1). Investigation shall occur when 30% or more ofa sample ofthe people exposed to it believe it to be objectionable in usual places ofoccupancy. The sample must be at least 20 people or 75% of those exposed iffewer than 20 people are exposed. NAC 445B.393(2).	The director shall deem the odor to be a violation if he is able to make two odor measurements within a 1hour period. These measurements must be separated by at least 15 minutes. An odor	http://www.statc.nv.us/cnr_menu.htm

STATE	ODOR REG. YESINO	LEVEL	METHOD	WEBSITE
			measurement consists of a detectable odor after the odorous air has been diluted with eight or more volumes ofodor free air. NAC 445B.393(3)	
New Jersey	Yes	When I spoke with New Jersey, they said they had odor provisions. However, when I received their fax ofthe regs. it appears that they limit "air pollution" and include odors within that although odors are not specifically mentioned in the definition. They also sent copy of their penalties for emissions. See attached NJCA § 7:2705.1 and NJSA § 26:2C-19		http://www.state.nj.usl d epl
New York	Yes	No person shall cause or allow emissions of air contaminants to the outdoor atmosphere of such quantity, characteristic or duration which are injurious to human, plant or animal life or to property, or which unreasonably interfere with the comfortable enjoyment of life or property. Notwithstanding the existence of specific air quality standards or emission limits, this prohibition applies, but is not limited to any particulate, fume, gas, mist, odor, smoke vapor, pollen, toxic or deleterious emission, either alone or in combination with others. §2l1.2 Notwithstanding the existence of specific standards, emissions ofodorous, toxic, or deleterious substance in concentrations or of such duration that will affect human health or well-being, or unreasonably interfere with the enjoyment of property, or unreasonably and adversely affect plant or animal life shall not be permitted. §2571.4(b)		http://unix2.nysed.gov/i ls/executive/enconlenc o n.htm
North Carolina	Yes	l5A NCAC §2D.0522. A person shall not cause, allow, or permit any plant to be operated without employing suitable measures for the control of odorous emissions including wet scrubbers, incinerators. or other devices approved by the commission. NC also adopted temporary odor rules for animal operations. Public hearing will be summer or 1999 and effective July 1,2000. Temp. rule specifies "applicable management practices for the control of odors" ISA NCAC 2D.IR02(c) and requires a "best management plan for animal operations" 15A NCAC 2D.1R03. Exemptions are provided for at 2D.0102.	May consider: 1) nature, intensity, frequency. pervasiveness ... , and duration; 2) potential to emit known odor causing compounds ... 3) any epidemiological studies ... 4) any other evidence, including complaints ...	http://www.ehnr.state.n c.uslEHNR
North Dakota	Yes	No person may discharge into the ambient air any objectionable odorous air contaminant which is in excess of2 odor concentration units. N.D. Admin. Code §33-15-16-02. 112S is restricted re: objectionable odors. Two samples with concentrations greater than 0.05 part per million (50 parts per billion)sampled at least fifteen minutes apart within a sixty minute period the measured in accordance with section 33·15-16-04 constitute a violation. § 33-15-15-02.1.	Barnebey-Cheney Scentomctcr or other instrumental method as approve by the Dept. An odor is objectionable when a Dept. certified inspector	http://www.health.state . nd.us/ndhdlenvironlee/ i ndex.htm

STATE	ODOR REG. YESINO	I LEVEL	METIIOD	WEBSITE
			or at least 30% ofa random group ofpeople, or an odor deem it objectionable if the odor were present in their place of residence.	
Oregon	Yes	They have several sections concerning odor regs. Wastes req. special management/agrie. waste--must be disposed of so as not to create odors ... § 340-093· 0190(l)(a). Incidental control practices for CAFO's-·app. ofmanure... should be done when air movements is least likely to carry objectionable odors to residential or recreational areas § 340-051-0075. Solid waste, storage and collection §340-093-0210(5)(b). Several others sections define "air contaminant" as including "odor," §§304-028-0110-Stationary source air poll. and 340·021·0005--gen. emission standards for particulate matter.		http://www.deq.state.or. us/odlruleslstatrule.htm
Pennsylvania	Yes	25 §123.31 • Malodorous air contaminants cannot be detectable outside the property ... Emissions shall be incinerated at a minimum of 1200°1' for at least OJ second prior to their emission into the outdoor atmosphere. Techniques other than incineration may be used ifthey are equivalent or better and arc approved in writing by the Dept. § 123Jl(e) provides an ago exemption: The prohibition in subsection (b) does not apply to odor emissions arising from the production ofagricultural commodities in their unmanufactured state on the premises of the farm operation. § 123.41 -A person may not permit the emission ... in such a manner that the opacity of the emission is either of the following: 1) Equal to or greater than 20% for a period or period aggregating more than 3 minutes in any I hour. 2) Equal to or greater than 60% at any time. The proposed amendments have received public comment and changes are being made to the draft. However, revised draft is still an internal documents and not available to the public vet.	Olfactory sense ofdept. personnel. They have proposed amendments to change certain things such as not having to provc public nuisance, changing some definitions, make it more tech. based, i.e. if a co. has implemented current tech. to control odor have a 5-year grace before being review/asked to do more.	http://www.dep.state.pa *.usl*
Rhode Island	Yes	No person shall emit or cause to be emitted into the atmosphere any air contaminant or combination of air contaminants which creates an objectionable odor beyond the property line of said person. Rule 17.	A statT member ofDiv. of Air Res. shall determine personnel observation if an odor is objectionable, taking into account its nature, concentration, location, duration and source.	http://www.health.state. i/yhd08.htm
Texas	Yes	Texas said they do have an odor reg. but what they faxed was a nuisance reg. which provides: No person shall discharge from any source whatsoever one or more air contaminants or combinations thereof, in such concentration and ofsuch duration as are or may tend to be injurious to or to adversely atTect human health or welfare, animal life. vegetation or property, or as to interfere with the normal use and enjoyment of		http://www.sos.state.tx.us/tac/30/1!index.html

STATE	ODOR REG. YESIN O	LEVEL	METHOD	WEBSITE
		animal life, vegetation, or property. § lOlA. Under their location standards for domestic wastewater treatment facilities they define "nuisance odor prevention" as: the reduction, treatment, and disposal ofpotential odor conditions that interfere with another's use and enjoyment of property that are caused by or generated from a wastewater treatment plant unit, which conditions cannot be prevented by normal operation and maintenance procedures ofthe wastewater treatment unit. § 309.11(6). Texas also adopted new "CAFO" rules in Aug. 1998. The buffer zone was increased to at least one-half mile from any occupied residence, business, school, public park, or church, unless the intervening landowner gives approval. In the alternative, new operations can be sited with at least a quarter-mile buffer if the owner develops and implements an odor control plan to minimize air contaminants. See 8-19-98 press release.		
Vermont	Yes	A person shall not discharge, cause, suffer, allow, or permit any emissions of objectionable odors beyond the property line of a premises. Subchapter II § 5-241(3). Vermont also has regs. for control of odor from industrial processes at Subchapter II § 5-241(3).	Vermont does not have rules concerning method. After a complaint, they go out and if there is an odor, thcy will try to determine the source and work it out.	http://www.anr.state.vt. us/dec/air/
Virginia	Yes	The rule applies to each facility that emits odor but does not apply to accidental or other infrequent emissions of odors. Pt. IV, Rule 4-2, § 120-04-0201. The board directs an investigation and the board may, at its discretion, hold a public hearing to hear complaints. Upon violation, the board approves measures for the economically and technologically feasible control ofodorous emissions. § 120-04-0204	The itlVestigation may include the use of an odor panel survey and/or other methods approved by the board.	http://legis.state.va.us/c odecornmlcodhome.htm
Washington	Yes	Under Washington's General Standards for Maximum Emissions there is an Odor section: Any person who shall cause or allow the generation of any odor from any source which may unreasonably interfere with any other property owners use and cnjoyment of his property must use recognized good practice and procedures to reduce these odors to a reasonable minimum. WAC § 173-400-040(4).		http://www.wa.gov/dnr/
West Virginia	Yes	No person shall cause, suffer, allow or permit the discharge of air pollutants that cause or contribute to an objectionable odor at any location occupied by the public. § 45-43(3.1). "Odor" means a sensation resulting from stimulation of the human sense of smell, § 45-4-2(2.5). Variance--An acceptable control program shall be developed and presented to the Director ... After approval, but the issuance of a variancc, the person responsible ... shall not be considered to be in violation ofthis rule. § 45-4-6(6.1). There is also a section on emergency circumstances -§ 45-4-6(6.2) and exemptions for "internal combustion engines" and ago operations -§45-4-7. West Virginia also has a draft of proposed amendments that they won't release just yet. It has a little more teeth, more options re: monitoring and enforcement but industry had input into it so not as tough • they would have liked to seen.	Barnebey-Cheney Sccntomoeter or any other instrument, device, or technique designated by the Director.	h!tp:/lwww.wvweb.com /~w/travel recreation/fishing/fishin g.html

STATE	ODOR REG. YES/NO	LEVEL	METHOD	WEBSITE
Wisconsin	Yes	No person may cause, allow or permit emission into the ambient air of any substance or combination of substances in such quantities that an objectionable odor is determined to result unless preventative measures satisfactory to the department are taken to abate or control such emission. NR 429.03(1). Tests: Decision resulting from investigation by the department, based upon the nature, intensity, frequency, and duration of the odor as well as the type of area involved and other pertinent factors OR when 60% of a random sample of persons exposed to the odor in their place of residence or employment, other than employment at the odor source, claim it to be objectionable and the nature, intensity, frequency and duration of the odor are considered. Wisconsin also sent a copy of a survey they use entitled: "Odors in Your Community."	An odor shall be deemed objectionable when either or both of two tests are met. (See description to the left.)	http://www.dnr.state.wi.us/
Wyoming	Yes	Odor emission at the property line is limited being undetectable at 7 dilutions with odor free air. Two measurements shall be taken within a 1 hour period, separated by at least 15 minutes. Reduction of animal matter gases etc. shall be incinerated at a temp. of not less than 1200°F for a period not less than 0.3 second, or processed by condensation or such manner as determined by the Division. Also regulates how odor producing materials are stored, transported, and handled. Section 16.	Barnebey-Cheney Scentometer or any other instrument, device, or technique designated by the Division as producing equivalent results.	http://www.dnr.state.wi.us/

APPENDIX C

SRF Consulting Group Inc. 2004

From SRF Consulting Group 2004

APPENDIX C4
SUMMARY TABLE OF STATE AND NATIONAL REGULATORY FINDINGS

State	Regulation	Authority	Complaint Verification	Determination Criteria	Notices of Violation	Penalties	Remedies	Permitting	Exclusions	Modeling	Staffing
Connecticut	Control of Odors	Department of Environmental Protection	-All complaints followed up on -Field observations by trained -No measurement technology or standards used	-strength -frequency -duration -characteristics	Issued when staff determines a nuisance exists	None	-Offending source notifies state within 30 days of its remediation steps -Compliance check	Air Quality?	-Mobile sources Residences with -6 or less dwelling units -Agricultural operations	Not used in permitting	12-13 FTEs
Oregon	Visible Emissions and Nuisance Requirements	Department of Environmental Quality (Small Business Assistance Program)	-All complaints followed up on -Field observations by trained -No measurement technology or standards used	-strength -frequency -duration -# of people impacted	Issued when staff determines a nuisance exists	Yes	Best Practices Agreement-implement abatement practices	Air Contaminant Discharge Permits	-Agricultural operations (handled by Oregon Department of Agriculture)	Not used in permitting	1-2 FTEs
Missouri	Restriction of Emission of Odors (geographic areas)	Department of Natural Resources	-All complaints followed up on -Scentometer 7:1 DT (non-ag) 5.4:1 DT (Class 1A CAFOs) 4:1 DT (St. Louis metro area)	-ambient odor criteria -annoyance criteria (St. Louis metro area)	Issued when staff determines a nuisance exists	Yes-monetary	Class 1A CAFOs—air monitoring quality assurance project plan & monitoring	Class 1A CAFOs—odor control plan Other sources—none required	-Agricultural operations	Not used in permitting	1 FTE per regional office
Idaho	Policy for Responding to Odor Complaints	Department of Environmental Quality (Regional Offices)	-Field observation -ASTM standard for butanol	-complaint criteria -intensity thresholds (level 4, butanol)	-If odor is substantiated, source is contacted -NOV can be issued when complaint is referred to State DEQ	Yes, through State DEQ enforcement process	Odor Management Plan	Odor Management Plans are required in order to receive an operating permit	Agricultural operations are handled by the Idaho Department of Agriculture	None	15% of 12 people's time
Rhode Island	Air Pollution Control Regulations No. 17 Odors	Division of Air Resources	-Complaint prioritization process -Field observation by trained staff -No measurement technology used or standards used	-annoyance criteria	-Source is notified if staff finds complaint to be valid	Yes	-state works with offending source to address problem -odor management plan	Air Quality Operating Permits	None identified in regulation	None	2.5 FTEs
North Carolina	Control and Prohibition of Odorous Emissions	Division of Air Quality	-All complaints followed up on -Staff trained in ASTM E54-99 determine if odor is objectionable	-intensity thresholds level 5	-Notified to implement best management plan -Notified to implement maximum feasible controls as a last resort	No	-state will work with source to develop a best management plan -If source does not comply, state can implement maximum feasible controls	None	Pulp mills, agricultural operations, mobile sources, wastewater treatment plants, restaurants, single-family homes, painting operations	None	??
North Carolina	Control and Prohibition of Odorous Emissions (animal operations)	Division of Air Quality	-All complaints followed up on -Staff trained in ASTM E54-99 determine if odor is objectionable	-intensity thresholds level 5	-Notified to implement best management plan	No	Best Management Plan	After 3 failures of the BMP, Air Quality permit is required	None	Required after 3 failures of BMP	??

APPENDIX C4
SUMMARY TABLE OF STATE AND NATIONAL REGULATORY FINDINGS

State	Regulation	Authority	Complaint Verification	Determination Criteria	Notices of Violation	Penalties	Remedies	Permitting	Exclusions	Modeling	Staffing
South Carolina		Department of Health and Environmental Control	-All complaints are followed up on within 48 horus -Field observations -No measurement technology or standards used	-complaint criteria				-Odor abatement plan is a permit requirement		None	
Vermont	Nuisance Law	Department of Environmental Conservation	-Field observations -No measurement technology -In the past surveys and panels were used	-complaint criteria -# of people impacted		Rarely used	State works with the offending source to remedy the odor problem	Agricultural operations		None	
Louisiana	This rule is not enforced	Department of Environmental Quality	-Odor panel	-intensity threshold level 6						None	
Massachusetts		Department of Environmental Protection	-All complaints are followed up on -Field observations -No measurement technology or standards used	-annoyance criteria			Offending source proposes a solution	Draft policy which requires sources to demonstrate that they will not exceed 5:1 DT	None	ICST modeling	
North Dakota			All complaints followed up on with an odor survey (inspector & scentometer)	-ambient odor criteria (7:1 DT) setbacks (outside city limits)						None	50-60 trained odor evaluators
Wyoming	Hydrogen Sulfide Regulation Ambient Air Standards	Department of Environmental Quality	All complaints followed up on (inspector & scentometer)	-ambient odor criteria 7:1 DT	Source is notified when a complaint is filed. If complaint is verified, notice of violation is issued			No		None	2 FTEs 1 assistant
South Dakota	-State does not regulate odor -State a law prohibiting them from adopting environmental standards, which are more stringent than Federal standards. -Odors could possibly be regulated under state nuisance law.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wisconsin	Malodorous Emissions and Open Burning	Department of Natural Resources	No measurement technology employed Random odorshed surveys	-complaint criteria	None	None	DNR will work with facility to determine the problem	None	None	None	DK

APPENDIX C4
SUMMARY TABLE OF STATE AND NATIONAL REGULATORY FINDINGS

Country	Regulation	Authority	Complaint Verification	Determination Criteria	Notices of Violation	Penalties	Remedies	Permitting	Exclusions	Modeling	Staffing
Australia (Victoria)	State Environment Protection Policy	Environment Protection Agency	-olfactometry samples taken from point sources -trained inspectors follow up on complaints	-dilution threshold criteria at source -ambient odor criteria (inspector in field)		Verification of a complaint can lead to prosecution		Yes-based on thresholds	Existing facilities	Yes	300 over the entire state
Western Australia	No regulation, only guidance for odor assessment	Department of Environmental Protection	-trained inspectors verify if odor is offensive -source sampling and dynamic olfactometry may be required	-annoyance criteria -dilution threshold	Environmental Field notice is sent to the offending source	Prosecution under Section 49 of the Environment Protection Act is possible, but rarely used	None addressed	Yes	Existing facilities	Yes	5 PTE odor complaints given low priority relative to other incidents.
Canada (Ontario)	Regulation 346	Ministry of the Environment	-all complaints followed up on -no measurement technology used	-contaminant thresholds -dilution threshold	Facility will be contacted even if inspector cannot detect odor. A facilitative process will be initiated to deal with the odor issue.	None mentioned	-Facilitative process -Extreme cases require source sampling using olfactometry	-mass balance -AP 2 -engineering assessment -source testing	Agricultural operations	-USEPA Screen III -Aeromod -ISC 3 10-min avg. -models based on 87 regulated contaminants	80 staff whose responsibilities include odor issues
Canada (City of Montreal, Quebec)	Law 90	City of Montreal	-all complaints followed up on -no measurement technology used in initial follow-up	-dilution threshold -emissions standards for VOCs, toxics, and other compounds	If inspector substantiates the complaint, source is notified	None mentioned	-permitting -source sampling using dynamic olfactometery	Yes	None	Yes	10 inspectors who deal with water and air issues

APPENDIX D

U.S. EPA 2004

USEPA 2004

Appendix B. State Website Internet Addresses				
State	Type	Agency	Rules	Website
Alabama	Guidelines	Department of Environmental Management	Guidelines and Minimum Requirements for Municipal, Semi-Public and Private Land Treatment Facilities	http://www.adem.state.al.us/ http://209.192.62.106/ Land treatment guidelines not found on website
Alaska	Regulations	Department of Environmental Conservation	Alaska Administrative Code, Title 18 - Environmental Conservation, Chapter 72, Article 2, Section 275 - Disposal Systems	http://www.state.ak.us/local/akpages/ENV.CONSERV/home.htm http://www.state.ak.us/local/akpages/ENV.CONSERV/title18/aac72ndx.htm
Arizona	Regulations	Department of Environmental Quality	Arizona Administrative Code, Title 18 - Environmental Quality, Chapter 11, Article 3 - Reclaimed Water Quality Standards and Chapter 9, Article 7 - Direct Reuse of Reclaimed Water	http://www.sos.state.az.us/ http://www.sos.state.az.us/public_services/Table_of_Contents.htm
Arkansas	Guidelines	Department of Environmental Quality	Arkansas Land Application Guidelines for Domestic Wastewater	http://www.adeq.state.ar.us/default.htm http://www.adeq.state.ar.us/water/branch_permits/default.htm Land application guidelines not found on website
California	Regulations	Department of Health Services	California Department of Health Services Regulations and Guideance for Recycled Water (The Purple Book) California Code of Regulations, Title 17 and 22	http://www.dhs.cahwnet.gov http://www.dhs.ca.gov/ps/ddwem/publications/waterrecycling/waterrecyclingindex.htm http://ccr.oal.ca.gov/
Colorado	Regulations	Department of Public Health and Environment	Water Quality Control Commission Regulation 84-Reclaimed Domestic Wastewater Control Regulation	http://www.cdphe.state.co.us/cdphehom.asp http://www.cdphe.state.co.us/op/regs/waterregs/100284.pdf
Connecticut	Neither	Department of Environmental Protection	---	http://dep.state.ct.us/
Delaware	Regulations	Department of Natural Resources and Environmental Control	Guidance and Regulations Governing the Land Treatment of Wastes	http://www.dnrec.state.de.us/dnrec2000/ http://www.dnrec.state.de.us/water2000/Sections/GroundWat/GWDSRegulations.htm
Florida	Regulations	Department of Environmental Protection	Reuse of Reclaimed Water and Land Application Florida Administrative Code - Chapter 62-610	http://www.dep.state.fl.us/ http://www.dep.state.fl.us/water/reuse/index.htm http://fac.dos.state.fl.us/
Georgia	Guidelines	Department of Natural Resources	Environmental Protection Division Guidelines for Water Reclamation and Urban Water Reuse	http://www.dnr.state.ga.us/dnr/environ/ http://www.ganet.org/dnr/environ/techguide_files/wpb/reuse.pdf
Hawaii	Guidelines	Department of Health	Guidelines for the Treatment and Use of Recycled Water	http://www.state.hi.us/doh/ http://www.state.hi.us/doh/eh/wwb/reuse-final.pdf
Idaho	Regulations	Department of Environmental Quality	58.01.17 Wastewater Land Application Permit Rules	http://www2.state.id.us/adm/index.htm http://www2.state.id.us/adm/adminrules/rules/idapa58/58index.htm
Illinois	Regulations	Environmental Protection Agency	Illinois Administrative Code, Title 35, Subtitle C, Part 372, Illinois Design Standards for Slow Rate Land Application of Treated Wastewater	http://www.ipcb.state.il.us/ http://www.ipcb.state.il.us/SLR/IPCBandIEPAEnvironmentalRegulations-Title35.asp
Indiana	Regulations	Department of Environmental Management	Indiana Administrative Code, Title 327, Article 6.1-Land Application of Biosolid, Industrial Waste Product, and Pollutant-Bearing Water	http://www.in.gov/idem/ http://www.in.gov/legislative/iac/title327.html
Iowa	Regulations	Department of Natural Resources	Environmental Protection Division Iowa Wastewater Design Standards, Chapter 21 - Land Application of Wastewater	http://www.state.ia.us/epd/ http://www.state.ia.us/epd/wastewtr/design.htm
Kansas	Guidelines	Department of Health and Environment	KDHE Administrative Rules and Regulations, 28-16. Water Pollution Control	http://www.kdhe.state.ks.us/ http://www.kdhe.state.ks.us/regs/
Kentucky	Neither	---	---	http://kentucky.gov/Default.html
Louisiana	Neither	---	---	http://www.state.la.us/
Maine	Neither	---	---	http://www.state.me.us/

Appendix B. State Website Internet Addresses Continued				
State	Type	Agency	Rules	Website
Maryland	Guidelines	Department of the Environment	Guidelines for Land Treatment of Municipal Wastewaters Title 26 Department of the Environment	http://www.mde.state.md.us/index.asp http://www.dsd.state.md.us/comar/subtitle_chapters/26_Chapters.htm
Massachusetts	Guidelines	Massachusetts Department of Environmental Protection	Interim Guidelines on Reclaimed Water (Revised)	http://www.state.ma.us/dep/dephome.htm http://www.state.ma.us/dep/brp/wwm/t5regs.htm
Michigan	Regulations	Department of Environmental Quality	Part 22 Rules of Part 31Groundwater Quality Rules Part 22 Guidesheet II Irrigation Management Plan Rule 2215 Various Aboveground Disposal Systems	http://www.michigan.gov/deq http://www.michigan.gov/deq/0,1607,7-135-3313_3682-14902--,00.html http://www.michigan.gov/deq/0,1607,7-135-3312_4117-9782--,00.html http://www.deq.state.mi.us/documents/deq-wmd-gwp-Rule2215VariousAboveGroundDisposalSystems-
Minnesota	Neither	---	---	http://www.state.mn.us/cgi-bin/portal/mn/jsp/home.do?agency=NorthStar
Mississippi	Neither	---	---	http://www.mississippi.gov/
Missouri	Regulations	Department of Natural Resources	Code of State Regulations, Title 10, Division 20, Chapter 8 - Design Guides	http://www.sos.mo.gov/ http://www.sos.mo.gov/adrules/csr/current/10csr/10csr.asp
Montana	Guidelines	Department of Environmental Quality	Design Standards for Wastewater Facilities, Appendix B - Standards for the Spray Irrigation of Wastewater	http://www.deq.state.mt.us/ http://www.deq.state.mt.us/wqinfo/Circulars/DEQ2.PDF
Nebraska	Regulations	Department of Environmental Quality	Title 119 Chapter 9 Disposal of Sewage Sludge and Land Application of Effluent - Regulations refer to the use of Guidelines for Treated Wastewater Irrigation Systems, February 1986	http://www.deq.state.ne.us/
Nevada	Regulations	Department of Conservation and Natural Resources	Divison of Environmental Protection Nevada Administrative Code 445A.275 - Use of Treated Effluent for Irrigation General Design Criteria for Reclaimed Water Irrigation Use	http://ndep.nv.gov/ http://ndep.nv.gov/nac/445a-226.pdf http://ndep.nv.gov/bwpc/wts1a.pdf
New Hampshire	Neither	---	---	http://www.state.nh.us/
New Jersey	Guidelines	Department of Environmental Protection-Division of Water Quality	Technical Manual for Reclaimed Water for Beneficial Reuse	http://www.state.nj.us/dep/dwq/techman.htm
New Mexico	Guidelines	Environment Department	Use of Domestic Wastewater Effluent for Irrigation	http://www.nmenv.state.nm.us/ Guidelines not found on website
New York	Guidelines	Department of Environmental Conservation	State Guidelines for the Use of Land Treatment of Wastewater	http://www.dec.state.ny.us/ Guidelines not found on website
North Carolina	Regulations	Department of Environment and Natural Resources	Administrative Rules, Title 15A, Chapter 02, Subchapter H, .0200 - Waste not Discharged to Surface Waters	http://www.oah.state.nc.us/rules/ http://ncrules.state.nc.us/ncadministrativ_/title15aenviron_/chapter02enviro_/default.htm
North Dakota	Guidelines	Department of Health	Division of Water Quality Criteria for Irrigation with Treated Wastewater Recommended Criteria for Land Disposal of Effluent	http://www.health.state.nd.us/wq/
Ohio	Guidelines	Environmental Protection Agency	The Ohio State University Extension Bulletin 860 Reuse of Reclaimed Wastewater through Irrigation	http://www.epa.state.oh.us/ http://ohioline.osu.edu/b860/
Oklahoma	Regulations	Department of Environmental Quality	Title 252 Chapter 621 and 656	http://www.deq.state.ok.us/mainlinks/deqrules.htm

Appendix B. State Website Internet Addresses Continued				
State	**Type**	**Agency**	**Rules**	**Website**
Oregon	Regulations	Department of Environmental Quality	Oregon Administrative Rules Use of Reclaimed Water from Sewage Treatment Plants - Division 55 340-055 Treatment and Monitoring Requirements for Use of Reclaimed Water	http://www.deq.state.or.us/wq/wqrules/wqrules.htm
Pennsylvania	Guidelines	Department of Environmental Protection	Bureau of Water Quality Protection Manual for Land Application of Treated Sewage and Industrial Wastewater	http://www.dep.state.pa.us/dep/deputate/watermgt/Wqp/WQP_WM/WM_Sewage.htm
Rhode Island	Neither	---	---	http://www.state.ri.us/
South Carolina	Regulations	Department of Health and Environmental Control	Administrative Code 61 Section 9.505 Land Application Permits and State Permits	http://www.lpitr.state.sc.us/coderegs/chap61/61-9.htm
South Dakota	Guidelines	Department of Environment and Natural Resources	Chapter XII Recommended Design Criteria for Disposal of Effluent by Irrigation Chapter XIII Recommended Design Criteria for Groundwater Monitoring Wells Chapter XVI Recommended Design Criteria for Artificial Wetland Systems	http://www.state.sd.us/denr/DES/P&S/designcriteria/designT.html
Tennessee	Regulations	Department of Environment and Conservation	Chapter 16 of Design Criteria for Sewage Works	http://www.state.tn.us/environment/
Texas	Regulations	Natural Resource Conservation Commission	Texas Administrative Code, Title 30 Environmental Quality, Part 1, Chapter 210 Use of Reclaimed Water	http://info.sos.state.tx.us/pub/plsql/readtac$ext.viewtac
Utah	Regulations	Department of Environmental Quality Division of Water Quality	Utah Administrative Code, Environmental Quality, R-317-1-4	http://www.rules.utah.gov/publicat/code.htm
Vermont	Regulations	Agency of Natural Resources Department of Environmental Conservation	Indirect Discharge Rules (for systems >6500 gpd) Wastewater Disposal Systems and Potable Water Supplies (for systems <6500 gpd)	http://www.anr.state.vt.us/ http://www.anr.state.vt.us/dec/ww/indirect.htm#IDRs http://www.anr.state.vt.us/dec/ww/rules/os/Final081602/Subchap5-6-081602.pdf
Virginia	Neither	Department of Environmental Quality		http://www.virginia.gov/cmsportal/
Washington	Guidelines	Department of Health State	Department of Ecology Water Reclamation and Reuse Standards	http://www.ecy.wa.gov/ecyhome.html http://www.ecy.wa.gov/biblio/97023.html
West Virginia	Regulations	Department of Health	Title 64 Series 47 Chapter 16-1 Sewage Treatment and Collection System Design Standards	http://www.wvsos.com/csr/verify.asp?TitleSeries=64-47
Wisconsin	Regulations	Department of Natural Resources	Natural Resources, Chapter NR 206 Land Disposal of Municipal and Domestic Wastewaters	http://www.dnr.state.wi.us/ www.legis.state.wi.us/rsb/code
Wyoming	Regulations	Department of Environmental Quality	Wyoming Water Quality Regulations Chapter 21-Reuse of Treated Wastewater	http://soswy.state.wy.us/ http://soswy.state.wy.us/RULES/2804.pdf

APPENDIX E

DEFINITIONS

DEFINITIONS (used in this report)(modified primarily from SRF (2004)

Ancillary Farm Operations (AFO) here refers to those manufacturing or industrial facilities which directly process raw farm products such as fruit, vegetables, meat or poultry into commercial consumer products.

Area Source is a surface-emitting odor source, which can be solid (for example the spreading of manure wastes or material stockpiles) or liquid (manure, storage lagoons, effluent treatment plants, effluent food processing residuals) or slurries (50% total solids/50% liquids)

Best Practices and Management plan here refers to those efforts/plans/activities, (technological, ecological, community awareness, good neighbor practices, etc.) undertaken in order to mitigate, lessen, or otherwise reduce detectable malodors emanating from process wastewater before and during land application for crop irrigation purposes.

BOD – biochemical oxygen demand. Biochemical oxygen demand (BOD) is a measure of the amount of oxygen that water-borne bacteria will consume while decomposing organic matter under aerobic conditions. Once the oxygen is used up, systems can turn anaerobic. (Brown and Caldwell)

Character – odor character is a qualitative attribute of an odor and is expressed in words that describe what a substance smells like (e.g. fruity or rotten eggs).

COD - chemical oxygen demand does not differentiate between biologically available and inert organic matter, and it is a measure of the total quantity of oxygen required to oxidize all organic material into carbon dioxide and water. COD values are always greater than BOD values, but COD measurements can be made in a few hours while BOD measurements take five days (Brown and Caldwell 2007)

Confined Animal Feeding Operation (CAFO)

Detection Threshold – the point at which an increasing concentration of an odor sample becomes strong enough to produce a first sensation in 50 percent of the people to whom the sample is presented (ISU 2004)

Duration – the period of time in which odorants are received by a receptor population and perceived as odors.

Electronic 'Nose'- class of analytical instruments based around an array of sensors each having a partial specificity producing an odor fingerprint that can be identified by a pattern recognition system (Strike 1998).

Food Processing Residual (FPR) is an incidental organic material generated by processing agricultural commodities for human or animal consumption. The term includes food residuals, food processing wastes, food processing sludges, food coproducts or any other incidental material whose characteristics are derived from processing agricultural products. Examples include: process rinse water from conveying food materials; fruit and vegetable peels; seeds, shells, pits; process wastewater treatment sludges; process wastewater from cleaning slaughter areas, rinsing carcasses, or blood; bone; cheese whey; off-specification food products; hides;

hair; and feathers.
An FPR recognizes the incidental materials generated during preparation of food products as resources, not as wastes. Use of waste/rinse waters from fruit and vegetable processing as irrigation water is considered a conservation water resource and soil organic matter and nutrient amendment when applied to fields of agricultural crops (Brandt and Martin 2001).

Frequency – how often an odorous emission will be experienced by a receptor population.

Hedonic Tone – hedonic tone describes the degree of pleasantness or unpleasantness and is a subjective assessment of the offensiveness of an odor.

Industrial and agricultural process water here refers to that portion of a waste stream that is made available for land application by irrigation as defined by Oregon DEQ (Dept. of Environmental Quality) in Guidelines for Land Application of Industrial Wastewater (Pour, 1992).

Intensity – refers to the perceived strength of the odor sensation and generally increases as a function of concentration.

Line Pigging – an internal pipe-cleaning process used to remove biofilms or other foreign matter from the inside of water pipes. A small device known as a 'pig' is inserted into the line which is pushed by water in the pipe in the direction of flow. The scraping of metal on metal creates a squealing noise like a pig so the name stuck. If performed correctly, line pigging will renew the flow rates to restricted piping systems and reduce pumping pressures (Satterfield 2007)

Malodor Source – unstable organics generally exposed to anaerobic conditions that facilitate decomposition of easily biodegradable materials resulting in the generation of malodorous gasses.

Odor is the perception experienced when one or more chemical substances in the air come in contact with the various human sensory systems (odor is a human response).

Odorant is any chemical that is part of the perception of odor by a human (odorant is a chemical).

Odor Concentration – measured as 'dilution ratios' and reported as 'detection threshold (DT) or 'recognition thresholds (RT) or as 'dilution-to-threshold' (D/T) and sometimes assigned the pseudo-dimension of 'odor units/cubic meter.'

Odor release to the atmosphere – malodorous gasses generated as a result of natural escape or mechanical introduction into the atmosphere.

Offensiveness – see Hedonic tone

Off-site odor transport – odorous emissions conveyed from the point of generation/release to nearby properties which are not under the control of the facility operator.

Point Source – an intentional point of release, such as a vent or a chimney

ppb – parts per billion

ppm – parts per million

Receptor Population – people who are or may be exposed to odor released from a given source.
Recognition Threshold – the point at which an odor can be identified.

Scentometer – brand of field olfactometer originally manufactured by Barneby-Cheney Company as a result of US Public Health Service Grants in 1958-60. Also a slang term for a field olfactometer)

VOC – Volatile organic compound

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APPENDIX F
Additional Readings

Gaseous Emissions from Wastewater Facilities
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Broiler Odor Concentration and Emissions

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Odor Measurement and Instrumentation

(Sweeney and Kabouris 2011)

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Shelterbelts
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A Report to Hermiston Foods, OR Department of Environmental Quality and the OR Department of Agriculture

HERMISTON FOODS REUSE WATER LABORATORY STUDIES

Christine Kelly, Jimmy Beaty and Josh Marsh
Chemical, Biological and Environmental Engineering
Oregon State University

Table of Contents

Executive Summary

A study was performed by Oregon State University to investigate the process waters that are applied to agricultural fields by the Hermiston Foods vegetable process facility in Hermiston Oregon. The first phase of the research included chemical characterization (pH, DO, BOD and COD) of waters from a variety of locations in the facility's water reuse system. As expected, COD was greater than BOD, and in general, pea and carrot waters (thousands of COD) contain much more COD than asparagus waters (hundreds of COD). Pea water had the lowest pH (around 4.0), with carrot higher at about 6.0, and asparagus the most neutral at 6.7. An undiluted short-term oxygen consumption rate (in contrast to BOD) in one water sample was found to be 4.1 mg/L min. The second phase of the research involved assessing odor of untreated and a variety of treated process waters. Odor was assessed via panels of participants that smelled untreated, treated and tap water samples. A variety of odor panel methodologies were used, with the following results generally observed:

- Odor increased with time in cold storage
- Raising the pH to neutral tended to decrease odor
- Rigorous aeration (open to atmosphere) decreased odor due to volatilization and removal from the water phase
- Solid removal tended to decrease or not affect odor
- Aerobic incubation in a closed vessel generally decreased sample odor
- Anaerobic conditions increased odor

A telephone survey of 43 northwestern companies that practiced process water agricultural reuse revealed that no companies engaged in operating practices or design explicitly to manage odors. This is in contrast to the Hermiston Foods where many operating practices and facility design decisions occur with the explicit intent to manage odors.

Because anaerobic decomposition of vegetable organics in the process waters was found to conclusively generate disagreeable odors, a hypothetical strategy was proposed using results from the study, as well as major assumptions, to reduce anaerobic decomposition in the part of the process where it is most likely to occur.

Scope

Beginning in summer of 2011, OSU and Hermiston Foods discussed efforts to address odor management concerns at the Hermiston facility. In the fall of 2011, Hermiston Foods selected a plan of work that included development of a Best Practices report and a laboratory-based study. OSU personnel travelled to Hermiston five times during this period to discuss and sample water (Kelly Dolan, Summer 2011; Kelly, Fall 2011; Silliman and Harper, Fall 2011; Dysart Winter 2012; Kelly, Summer 2012). This report describes the results from the laboratory-based study, in which many students participated. Personnel and their roles on the project are indicated in Appendix A.

The original Statement of Work agreed upon in Fall 2011 follows:

> *OSU will conduct laboratory studies focused on determining the retention time for waters to transition from aerobic to anoxic and finally anaerobic conditions. The independent variables examined will include the following: time, water type (pivot, process, vault, and lagoon waters, as well as irrigation and well water for controls), aeration, inoculum, pH, temperature and vegetable solids. Waters from each vegetable process will be used, requiring collection in fall 2011 and spring/summer 2012. The matrix of experiments will be determined after preliminary design of the experimental set-up (for example, a simpler set-up, without the need for sacrificial treatments, will allow for testing more conditions). Measurements will include biological oxygen demand, chemical oxygen demand, dissolved oxygen, pH, temperature, and semi-quantitative and qualitative odor.*
>
> *Odor is difficult to quantify and characterize. We will use dilution-to-threshold techniques (odor concentration) with a panel of researchers. This method, like others, has limitations. We will establish a standard odor testing procedure based on current state-of-the-art methods, and adhere to the procedure for each sampling. In addition to odor concentration, we will also use the panel to qualitatively rank the intensity and offensiveness of an odor from the diluted samples. Typically, a scale of 0 to 10 is used, with 0 indicating no odor or not offensive and 10 representing a very intense or offensive odor.*
>
> *These experiments focus on the potential for waters to produce anaerobic conditions and generate pungent or putrid odors. The results from these experiments may identify which waters and what conditions (temperature, pH, presence of microbes, etc.) have the highest potential for generating odors, and how quickly odors are generated. This information will improve understanding of odor generation and may be used for a variety of odor control and management strategies (e.g. validate the effect of the new screens installed at the facility, inform decisions on rinsing of pivot and transport lines as a function of temperatures, inform lagoon management strategies). The results and conclusions from the experiments will be compiled in a report to NORPAC with an analysis of how the results may impact odor control and management and the Hermiston facility.*

Site and Process Description

Hermiston Foods is located in Hermiston, OR and processes asparagus, peas, sugar snap peas, lima beans, edamame, and carrots. The processing includes washing, mechanical treatment and bulk freezing for individual packing elsewhere. The waters from this process, vegetable washing and freezer defrosting waters, have been applied to agricultural fields for over 15 years. However, a few years ago the location of water application was changed to fields east of the main facility. Subsequently, complaints regarding odor were received from neighboring residences, which motivated this study.

The water application system consists of a screening facility and vault at the processing facility. The vault at this location is termed the pit so as not to confuse this site with the vault in the agricultural fields. The water is pumped approximately 3 miles in an underground pipe (about 4 ft. subsurface) through agricultural fields east of the facility to a vault that is adjacent to a lagoon. A map of these features is depicted in Figure 1.

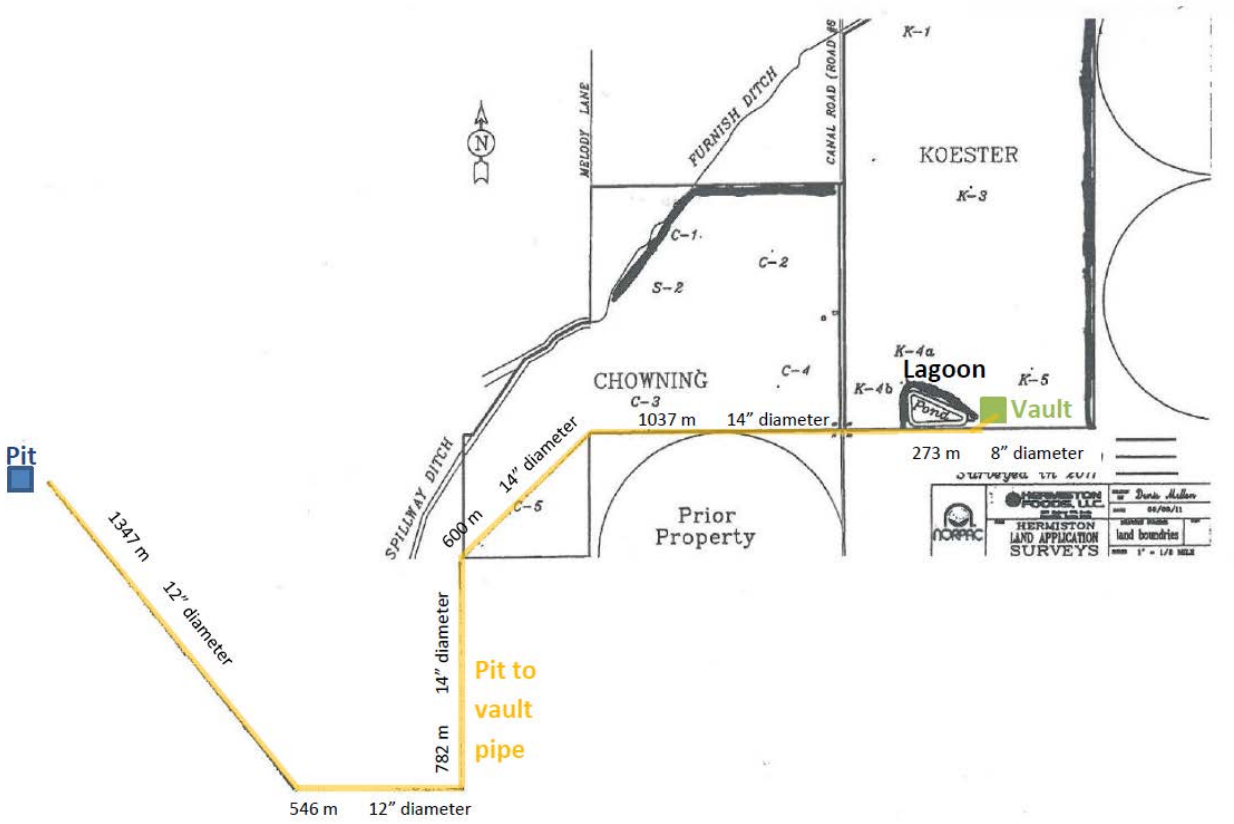

Figure 1. Water application map illustrating the pit (blue, left) at the Hermiston facility, the pipe to the vault (orange line), the vault (green, right).

At the facility, the process water, containing dissolved organic compounds, is passed through screens (Figure 2) to remove solids, and into the 20,000 gal pit directly outside the facility. The water in the pit is pumped to the vault by two 75 hp pumps on the dry side of the pit (Figure 3).

Figure 2. Screens to collect solids prior to the water storage pit at the Hermiston processing facility.

Figure 3. Pit dry side pumps for transport from pit to the vault.

The flow is variable from the speed controlled pumps, with a maximum of about 2000 gpm for 40 minutes, four times per day during freezer defrosting and wash-up. During these periods, the second pump is toggled on to accommodate the higher flow rate. The average flow is 450 gpm, and maximum is 2000 gpm. Using these values, the average flow during the non-defrosting and wash-up periods is about 253 gpm. The pumps are operated automatically to maintain a 50” level in the pit. Storm water from the facility is also routed to the pit.

The water is pumped through six straight pipe segments to the vault, as indicated in Figure 1. Table 1 indicates the approximate residence time in the pipe at the maximum, overall average, and non-defrosting and wash-up average flow rates.

Table 1. Pit to Vault Underground Pipe Details

Segment	Length (m)	Diameter (in)	Volume (gal)	Residence Time (min) @450 gpm	@253 gpm	@2000 gpm
1	1347	12*	25943	57.5	102.5	13.0
2	546	12	10516	23.4	41.6	5.3
3	782	14	20500	45.6	81.0	10.2
4	600	14	15729	35.0	62.2	7.9
5	1037	14	27184	60.4	107.4	13.6
6	273	8	2337	5.2	9.2	1.2
Totals	4585 m or 2.8 miles		102 200 gal	227 min or 3.8 hr	404 min or 6.7 hr	51 min or 0.9 hr

* 16 in for a very short length – assumed 12 in entire length.

The vault is a covered rectangular cement structure of 30,000 gal with a 4 ft. headspace above the liquid level (Figure 4). There is ample exchange with outside air. Aeration in the vault is provided by intermittent, vigorous discharge into the water in the vault (Figure 5).

Figure 4. Vault structure showing a window for interchange with the atmosphere and screens above.

Figure 5. Interior of the vault showing frothy discharge from screens above.

Water can be stored in the lagoon adjacent to the vault. Lagoon water, irrigation ditch water, and well water are added to the vault. As an odor control practice, Hermiston Foods pumps water directly from the vault to the irrigation pivots when possible. In our limited visit experience, if there is odor from the water, the odor is present at the vault; it does not solely develop in the pivots.

Water Characterization (Physical/Chemical)

Water samples were obtained from Hermiston Foods by collecting samples during visits and by mailings from Hermiston to OSU. In both instances, water was transported in cold (ice chest/dry ice packaging) containers and then stored at 4^{o}C until use. pH, chemical oxygen demand, biological oxygen demand and oxygen consumption rate were measured from samples.

Oxygen Demand and pH

Both chemical and biological oxygen demand assays determine the amount of oxygen required to oxidize carbon compounds in a sample to CO_2 and water. Chemical oxygen demand (COD) is experimentally determined by adding a strong oxidizing agent to the sample and measuring the CO_2 formed over time. Biological oxygen demand is determined by adding a microbial inoculum to the sample and measuring the decrease in oxygen concentration over time. Both are presented in units of mg O_2 required for oxidation/L of sample. Chemical and biological oxygen demand and the pH of several water samples were measured, and are indicated in Tables 2 (fall) and 3 (spring).

Table 2. Fall 2011 sample BOD and COD Measurements

Sample Date	Sample Location	Vegetable Processed	BOD_5 (mg/L)	COD (mg/L)
10/16/2011	Vault	Lima bean	1450	2000
11/3/2011	Vault	Carrot	3440	5440
11/8/2011	Pit	Carrot	3410	6250
11/8/2011	vault	Carrot	4290	6600

Table 3. Spring and Summer 2012 sample COD, BOD and pH Measurements

Sample Date	Sample Location	Vegetable	COD (mg/L)	pH
5/10/2012	Pit	Asparagus	193	6.7
5/16/2012			273	6.6
5/23/2012			183	6.9
8/2/2012		Carrot	4620	5.2
8/9/2012			2130	6.5
8/15/2012			5500	5.7
8/23/2012			1050	6.3
8/29/2012			3850	3.9
9/20/2012			4620	4.4
9/26/2012			5120	6.0
6/6/2012		Pea	3640	3.9
6/12/2012			7900	4.0
6/21/2012			4770	3.9
7/17/2012			1230	4.7
7/26/2012			3010	4.2
5/23/2012	Vault	Asparagus	157	6.7
8/9/2012		Carrot	1210	6.4
8/15/2012			984	6.2
8/23/2012			2190	4.3
9/20/2012			2050	5.0
9/26/2012			3320	4.6
6/6/2012		Pea	976	4.7
6/12/2012			1080	4.4
6/21/2012			2970	4.5
6/12/2012	Pivot	Pea	600	4.9

COD is often higher than BOD due to the fact that some of the carbon compounds are not accessible for biological transformation, but are susceptible to chemical oxidation. In general, pea and carrot waters (thousands of COD) contain much more COD than asparagus waters (hundreds of COD). Although the values vary widely with time, based on these sampling points vault water may contain lower COD than pit water. The reasons for this include dilution of the process water in the vault by ditch or well water, potential microbial metabolism of carbon compounds, sample timing. Samples were not taken from the pit and vault at the same time, and the flow is variable due to plant operations (e.g. vegetable washing vs. sanitation/defrosting). Collections from the vault could have occurred during a low COD operation (defrosting).

There does not seem to be a consistent difference in pH between the pit and vault water for a given processed vegetable. A lower vault pH would be a clear indicator of anaerobic metabolism. However, for a given processed vegetable, there are significant differences in pH. Pea water is the lowest pH (around 4.0), with carrot higher at about 6.0, and asparagus the most neutral at 6.7 pH.

Two on-site sampling events were performed by OSU personnel (Kelly) on 10/16/2011 and 6/12/2012. Temperature, pH, and dissolved oxygen (DO) measurement were taken at a variety of locations in the Hermiston Foods water reuse process.

On the October sampling date (10/16/2011), according to operating personnel, the plant was processing primarily lima beans, with some carrot rework. At this time the pit water sampled was accidently taken from the basin in the pit with the pump float control, which does not contain process water, so no data is available for the pit. The observations from this sampling event are below. The notes are plant operations as described at the time of sampling by Hermiston Foods staff.

> ***Vault*** (no dilution by well or ditch water occurring, pure process water, intermittent low odor, very foamy)
> pH and DO measured in a collection container (dipper) immediately after collection as opposed in the vault directly
> T = 18.3^{o}C, pH = 4.1, DO = 76%, slowly declining
>
> ***Lagoon*** (lagoon level low, aerators off due to low level, bubbles rising from beneath the surface, little to no odor)
> T = 20.3^{o}C, pH = 3.9, DO = 4%
>
> ***Pivot drag line*** (very foamy, pivot K3, some odor)
> pH and DO measured in bottle directly after collection from the drag line
> T = 20.3^{o}C, pH = 4.3, DO = 100%
>
> ***Ditch*** (almost ready to turn off, very clear, almost no algae growth)
> T = 17^{o}C, pH=6.8, DO =100%

During the June 2012 date, the plant was processing primarily peas according to operating staff. The observations from this sampling event are below.

> ***Pit*** (little odor, pleasant characteristic, processing peas)
> pH and DO measured in sampling dipper as described above
> pH = 6.6, DO = 6.5 mg/L
>
> ***Vault*** (no dilution, pure process water, significant unpleasant odor)
> pH and DO measured in sampling dipper as described above
> pH = 4.6, DO = 8.3 mg/L
>
> ***Pivot drag line*** (some odor)
> pH and DO measured in bottle as described above
> pH = 4.9, DO = 7.8 mg/L

Oxygen Consumption Rate

Respirometry is a method to quantify the oxygen removal in a liquid sample due to microbial consumption of oxygen. Alhtough respiromety and BOD are both measures of microbial consumption of oxygen, they are different assays. In the BOD method the change in oxygen concentration in a *diluted* sample is measured from an initial and final value over a long time period (5 days). In respirometry, an *undiluted* sample is used, and the time course (over a short time period) of dissolved oxygen is measured. The respriometry instrument includes an oxygen meter, oxygen probe, and temperature controlled well for a liquid sample. The probe inserts into the stirred vessel such that there is no vapor head space (Figure 6). Three mL of undiluted pit water were placed into the vessel along with different amounts of activated sludge inoculum. The % dissolved oxygen (DO) saturation was recorded with time. As the microbes consumed the oxygen in the water, the DO decreased. Because there is no air headspace in the vessel, additional oxygen cannot dissolve into the water.

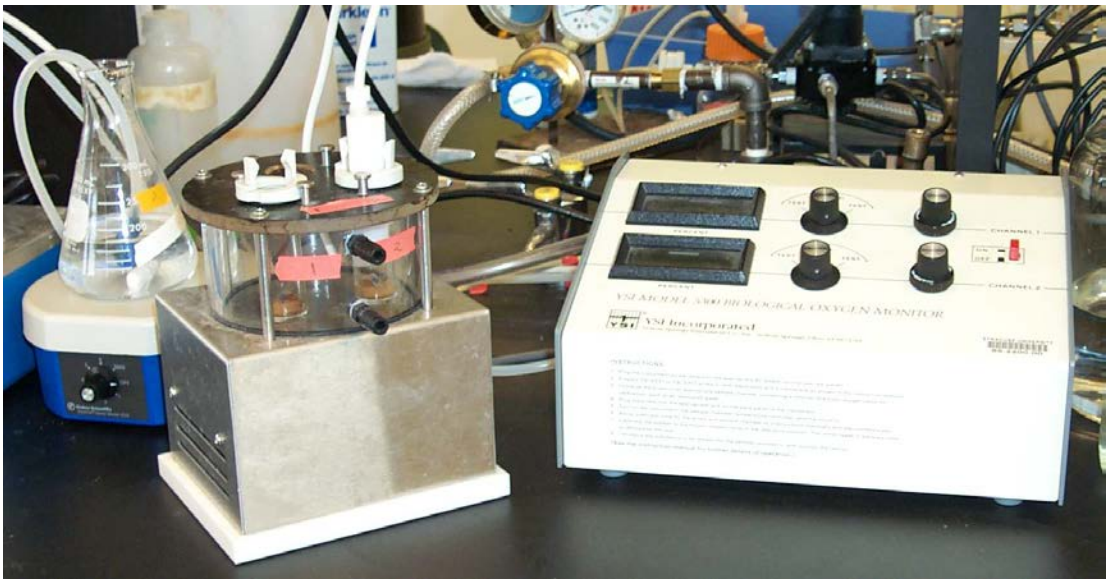

Figure 6. Respirometer. Right: Oxygen meter. Left: temperature controlled (via bath) wells (3) and oxygen probe.

Activated sludge, microorganisms, from the Corvallis waste water treatment plant was used to inoculate the pit water for oxygen consumption experiments. Three different amounts of activated sludge inoculum were investigated. The dissolved oxygen concentration was recorded multiple times per minute and plotted as shown in Figure 7 (Left panel). The region of highest rate of oxygen consumption was identified (the first three points) and were plotted (Figure 7 [Right panel]) and the slope of the regression line was calculated.

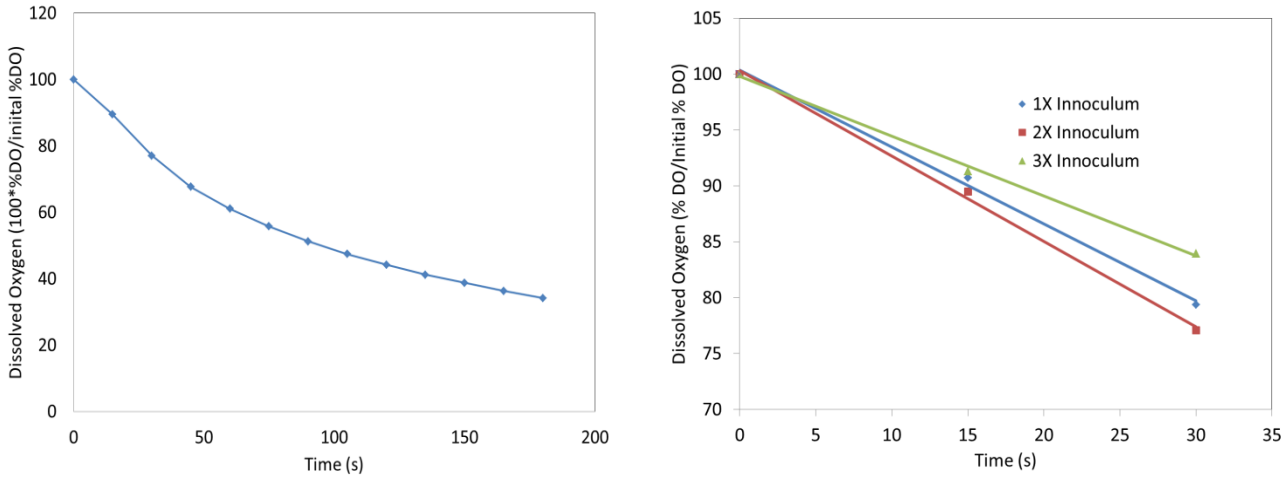

Figure 7. Left: Respirometry (entire time) of the 2X inoculum. Right: Liner range (first three time points) of respirometry for the 1X, 2X and 3X inoculum cases. 1X refers to 1 mL of activated sludge and 2 mL of pit water. 2X refers to 2 mL of activated sludge centrifuged with 1 mL supernatant removed and 2 mL of pit water. 3X refers to 3 mL of activated sludge centrifuged with 2 mL of supernatant removed and 2 mL pit water.

The slope of the lines represents the maximum amount of oxygen that can be consumed in this sample of pit water per time in % dissolved oxygen saturation. The respirometry data is in Appendix B. Essentially the three inoculums investigated yielded the same oxygen consumption rate (i.e. we did not observe increased consumption rate with increasing biomass inoculum). This may be due to diffusion limitations rather than microbial rate limitations. From the average rate, the maximum mass of oxygen that can be consumed in a liter of this specific sample of vault water is about 4.1 mg/L min (Equation 1).

$$Maximum\ oxygen\ consumed\ = \frac{0.76\ \%DO}{s} \cdot \frac{\frac{9\ mg\ DO}{L}}{100\ \%DO} \cdot \frac{60s}{min} = 4.1\ \frac{mg\ DO}{L\ min} \qquad Eq.(1)$$

At this rate of consumption, all of the oxygen in a liter of water would be consumed in less than three minutes. This is a maximum amount (due to a large inoculum) and only from one sample; therefore it should only be considered an order of magnitude approximation of what may be observed over time. At this rate it is likely that all of the oxygen in the pit water (solubility about 9 mg/L) would be consumed early in the transport to the vault. Recall the residence time in the underground pipe is about 1 hr at the highest flow rate. At the lower flow rates, the residence time is greater, making it more likely that the oxygen would be consumed.

Odor Assessment

Human Subjects Institutional Review

OSU requires a human subjects institutional review prior to the use of human subjects in research. The use of students and staff in the odor panels may have required an approved protocol. However, to be evaluated by the OSU institutional review board (IRB) and full protocol must be developed, even when applying for exempt status. A complete application was prepared for odor testing (using students and other OSU personnel). The research protocol section of the application is attached in Appendix C. IRB judged the project not to be research because we did not intend to publish the results of the odor panels as research, so odor panels were considered exempt from review.

Odor Assessment Methods

Three types of odor assessment methodologies have been utilized: dilution threshold, ranking and rating. Each method has associated advantages and disadvantages. Water samples have been subjected to addition of inoculum, aeration, agitation, incubation, pH adjustment, and solid removal and the impact on odor assessed.

Dilution Threshold

Dilution Method

The OSU researchers treated the sample water from Hermiston Foods. At the conclusion of the treatment, a sample of the untreated water is removed from the cold room. Both the treated and untreated samples are allowed to come to room temperature. Dilutions are made with both samples in tap water (RO water inherently had an odor). The researchers selected a dilution that has just detectable odor, and prepared two additional dilutions above and below the just detectable dilution. We investigated ranges between dilutions and selected 0.5% (0.05 mL sample in 10 mL total) increments of sample in tap water. This results in five dilutions for the treated sample, and five dilutions for the no treatment sample. Ten mL of each dilution were placed in a 250 mL bottle with a sleeve covering the contents of the bottle. Each bottle with a sample dilution was paired with two bottles containing tap water. Groups of three bottles (one dilution and two tap water controls) were placed in random order on the lab bench.

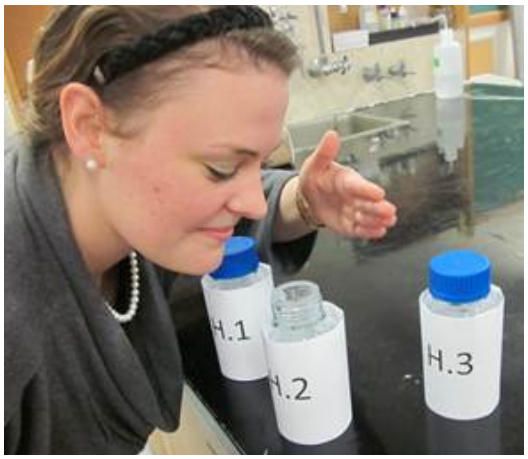

Figure 8. Image of a dilution odor panelist smelling a dilution unknown.

The panelists were asked to briefly shake each bottle to evenly distribute the contents, then remove the cap and smelled the odors (if any) that emanate from the bottle (Figure 8). The panelists then smelled each of the three bottles and on a prepared sheet indicate which panel has an odor (or the strongest odor). If they could not detect an odor, they guessed which of the three

had an odor. *The odor threshold is the lowest dilution that 100% of the panel identified as having an odor*.

Dilution Challenges
The dilution method has several associated challenges. Initially it was difficult to determine the appropriate interval between dilutions and the number of dilutions to use. If the range was too narrow, there was a risk that all or none of the panelists would identify the correct bottle, thereby a threshold could not be identified. A more fundamental issue with this protocol was that we do not know if a threshold odor equates to an odor at the sample concentration. The primary reason we moved to a different type of protocol is the high level of resources (time, people, effort) to obtain a single odor evaluation. We could only test one treatment and a no treatment control at a time (which equates to 30 bottles to smell) due to panelist fatigue.

Dilution Results and Summary

Twenty-five dilution threshold odor panels were held between October 2011 and January 2012. The effects of 3 hrs of aeration, incubation, pH neutralization, solid removal, and temperature were investigated. The dilution thresholds for each of these tests are indicated in Table 4. In this table the treatment abbreviations refer to the following:

N/T = No Treatment
no solids = solids were removed by centrifugation.
aerated = liquid sample sparged with air, vessel open to the atmosphere
pH = pH adjusted to neutral (7.0)
incub 30^{o}C = 3 hours at 30^{o}C without shaking or innoculum
closed shaking = vessel on an orbital shake, head space, not open to atmosphere

The threshold of each of the treated sample should be compared to the associated N/T sample. ***A higher threshold percentage means less odorous water***. For example, the first to rows in Table 4 indicate that removing solids from the carrot vault water sample reduced odor (4.5% threshold for solids removed vs. 3.0% for no treatment).

Table 4. Summary of the 25 dilution threshold odor panels. The shaded entries were performed with mailed water samples and the * entries had either too high or too low dilution ranges. ***A higher threshold percentage means less odorous water.***

Date	Vegetable	Sample Location	Treatment	# Panelists	Threshold
	Carrot	Vault	N/T	8	3.0%
10/24/2011	Carrot	Vault	no solids		4.5%
	Carrot	Vault	aerated	10	7.5%
10/28/2011	Carrot	Vault	Aerated + pH adjusted		6.0%
	Carrot	Vault	N/T	5	2.5%
10/31/2011	Carrot	Vault	pH		3.5%
	Lima Bean	Vault	N/T	12	2.0%
11/4/2011	Lima Bean	Pivot	N/T		2.5%
	Lima Bean	Vault	N/T	5	1.7%
11/7/2011	Lima Bean	Vault	pH		2.0%
	Carrot	Vault	N/T	7	0.15%
12/20/2011	Lima Bean	Vault	N/T		0.50%
	Carrot	Vault	aerated	6	11.0%
12/21/2011	Carrot	Vault	N/T		0.85%
	Lima Bean	Vault	N/T	6	*
12/22/2011	Lima Bean	Vault	pH adjusted		*
	Carrot	Vault	N/T	7	0.25%
1/4/2012	Carrot	Vault	no solids		1.5%
	Carrot	Vault	pH adjusted		0.25%
	Carrot	Vault	N/T	6	0.075%
1/5/2012	Carrot	Vault	incub 30°C		0.10%
	Carrot	Vault	incub 37°C		0.30%
	Lima Bean	Vault	N/T	6	0.55%
1/6/2012	Lima Bean	Vault	aerated		0.80%
	Lima Bean	Vault	closed shaking		0.70%

During fall 2011, we were primarily working with water samples collected from Hermiston Foods during one of our visits. However, we also received some samples through the mail. The odor from the sample waters tended to increase during storage in our cold room (4°C) (Figure 9). Therefore, we needed to perform a no treatment control with each treatment. The no treatment control was performed the same day, except for one treatment where it was performed 4 days prior.

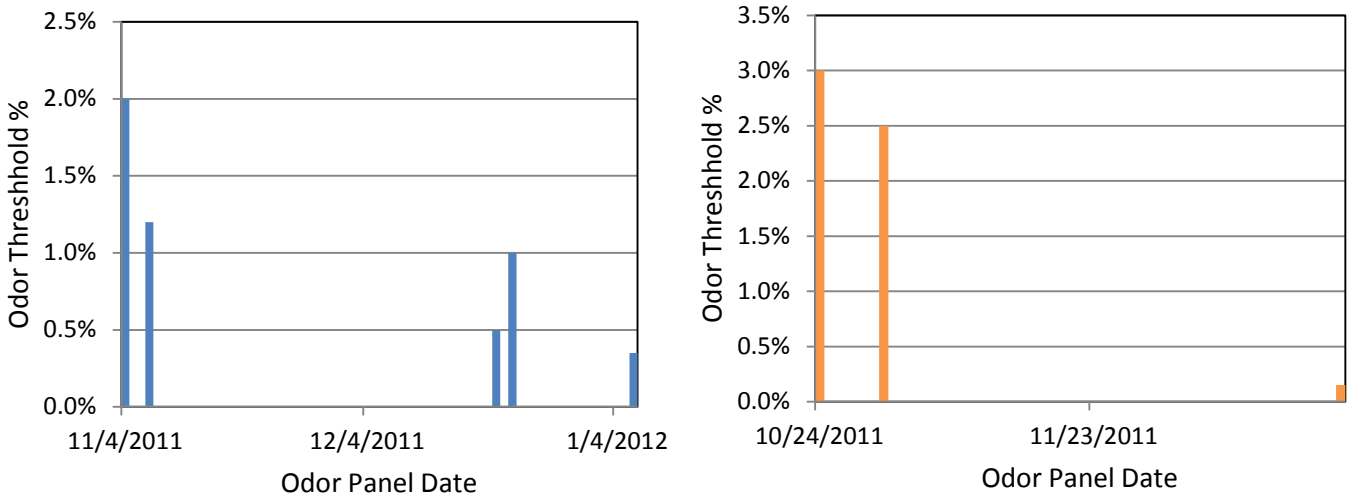

Figure 9. Stability of odor with storage time at 4°C. Higher threshold means more sample can be added without detecting an odor (less odor present). Left panel: Vault water from lima bean processing (sampled 5 times over the storage period). Right panel: Vault water from carrot processing (sampled 3 times over the storage period).

Figure 10 summarizes the carrot vault water dilution panels from Table 4. Three panels with lima bean vault water were also performed with similar trends observed.

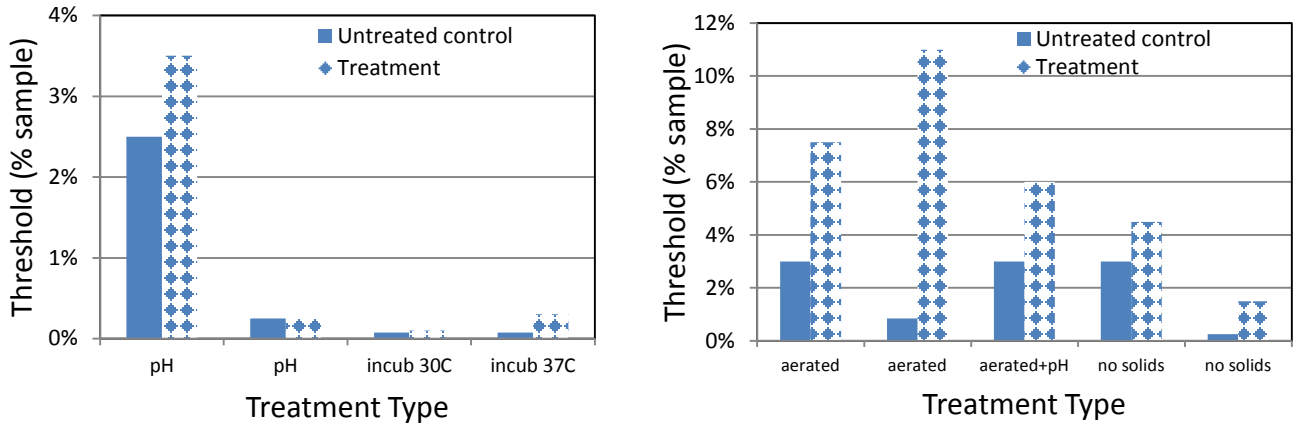

Figure 10. Effect of treatments on odor threshold on carrot vault water. Left panel: Effect of pH adjustment to 7.0 with two different water samples, incubation with no inoculum added at 30 and 37°C. Right panel: Effect of aeration (open to sparged air, open to atmosphere) with two different water samples, combined aeration and pH neutralization, and solids removal by centrifugation with two different water samples. A higher threshold % means that more sample was required to detect an odor (less odor present).

The following trends were observed in our dilution odor panel tests:

- Odor increased with time in the cold room (Figure 9).
- Raising the pH to neutral and incubation (at 30 and 37^{o}C with no inoculum) resulted in little or no change in odor (Figure 10 Left panel. Note the scale compared to the Right panel).
- Rigorous aeration (open to atmosphere) decreased odor (Figure 10 Right panel). We hypothesize this is primarily due to volatilization and removal from the water, rather than biological transformation.
- Solid removal decreased odor (Figure 10 Right panel).

Odor Order Ranking

A ranking method was developed to enable more treatments to be examined in a single odor panel. This method essentially removes the dilution portion of the assessment and asks the panelists to directly rank the treated samples in order of odor offensiveness and intensity.

Ranking Method
Researchers treated the sample water from Hermiston Foods. At the conclusion of the treatment, a sample of the untreated water was removed from the cold room. Both the treated and untreated samples were allowed to come to room temperature. Ten mL of each treated sample were placed in a 250 mL bottle with a sleeve covering the contents of the bottle. The panelists were asked to briefly shake each bottle to evenly distribute the contents, then remove the cap and smell the odors (if any) that emanate from the bottle. The panelists then smelled each of the bottles. On a prepared sheet they ranked the bottles on scale of 1 to 5 in terms of decreasing odor offensiveness and intensity. The average ranking of the treated sample was compared to the average ranking of the untreated sample to assess if the odor increased or decreased.

Ranking Challenges
The ranking method also has an associated challenge: the method does not indicate the magnitude of differences from the no treatment control. For example (this occurred during one of our panels), if four of the bottles (including the no treatment control) have very little difference in odor, but one of the bottles has a much more offensive and intense odor, this method did not capture that difference in magnitude.

Ranking Results and Summary
Ten ranking odor panels were performed in the spring and summer 2012, with 5 to 10 panelists in each odor panel. The effects of aeration, incubation with and without inoculum, temperature, pH neutralization, and solid removal were investigated using vault water. In general, the results are indicted by plotting the difference between the no treatment control and the treatment. A positive number means the treatment had a more intense or offensive odor than the no treatment control. Recall that the plotted delta may or may not be representative of magnitude of difference. The value may reflect what other treatments were included in the panel (typically five treatments in each panel) and the initial odor of the water sample – the value is a ranking of order of treatments according to odor, not a rating of odor.

The trends that were observed in the ranking panels (Figures 11-13) include the following:

- 3 hour aeration (open to atmosphere, stripping) generally decreased sample odor intensity and offensiveness. (Figure 11). Stripping is not a strategy that would be implemented at a facility because it simply transfers the odor from the water to the gas (air) phase, and we result in a greater mobility of odors.
- 3 hour incubation (without inoculum, with headspace – aerobic) generally decreased sample odor intensity and offensiveness at all temperatures (Figure 12). This may be due to aerobic metabolism of some odor compounds, but not stripping due to the closed vessel.
- pH adjustment to neutral (pH 7) consistently decreased sample odor offensiveness and intensity (Figure 13).
- In these very short term experiments, solid removal had little to no effect on odor (Figure 14). However in a full-scale facility it is well known that removing solids significantly decreases odor because the solids will contribute a large source of BOD that would be available for anaerobic microbial metabolism.

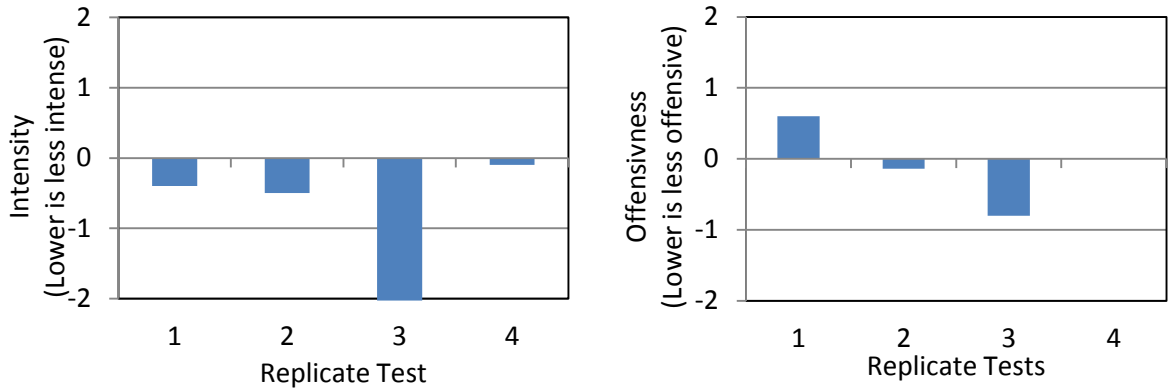

Figure 11. Effect of 3 hr aeration (sparging, open to atmosphere) on odor using the ranking method. Samples are the same carrot vault water, taken at different times from cold storage, therefore the initial odor was different. Recall that initial odor of samples vary; therefore stripping would have a conclusive effect if the odor was significant initially, but a less conclusive effect if the initial odor was minimal.

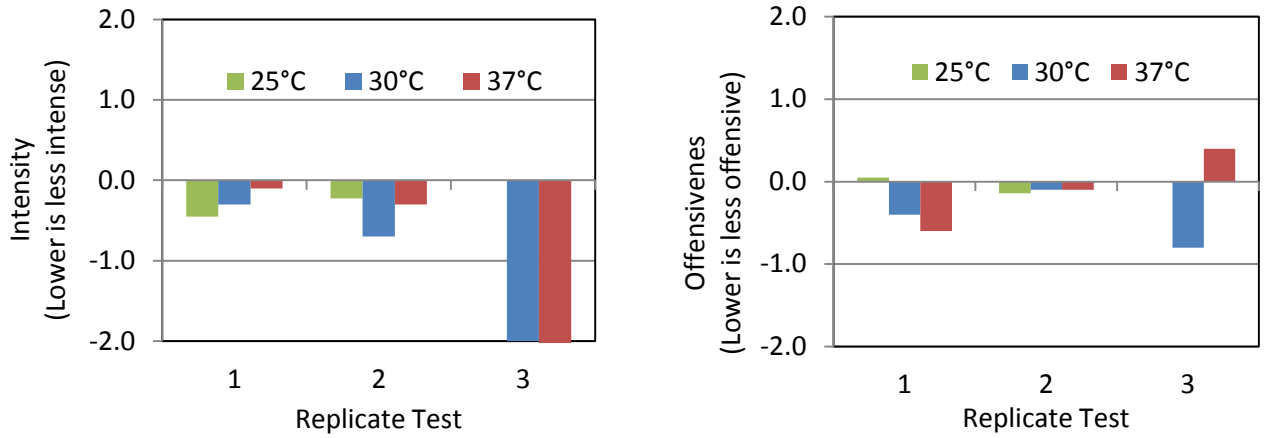

Figure 12. Effect of 3 hr incubation (with headspace, no stripping, aerobic) at various temperatures on odor using the ranking method. Samples are the same carrot vault water, taken at different times from cold storage, therefore the initial odor was different

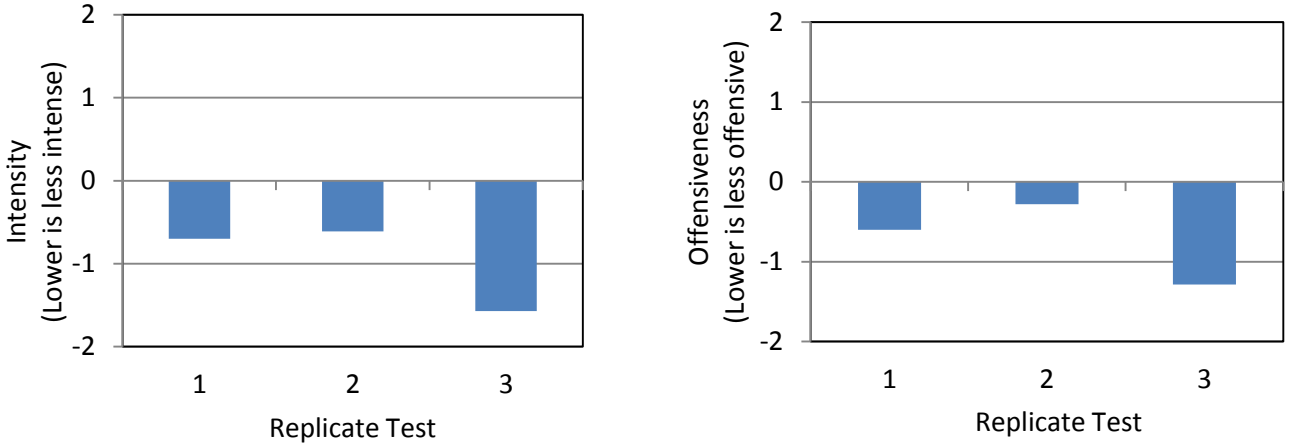

Figure 13. Effect of pH neutralization on odor using the ranking method. Samples are the same carrot vault water, taken at different times from cold storage, therefore the initial odor was different.

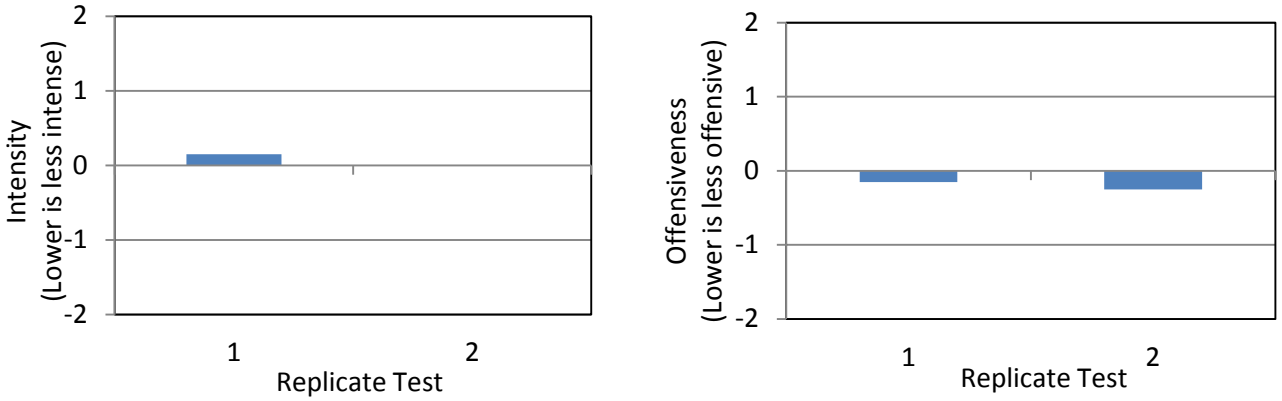

Figure 14. Effect of solid removal (by centrifugation) on odor using the ranking method. Samples are the same carrot vault water, taken at different times from cold storage, therefore the initial odor was different. A close to 'zero' ranking indicates about ½ the panelist ranked the odor more intense/offensive than the no treatment control, and about ½ ranked the odor less intense/offensive.

The ranking method was also used to assess the effect of inoculum (anaerobic digester broth) and incubation time on the development of odors using pit waters (Figures 15-17). The plots indicating these results use the actual ranking rather than the difference from a no treatment control, as we are comparing treatment variables (time and inoculum).

The trends that were observed in pit water anaerobic treatments (Figures 15-17) include the following:

- Increasing inoculum load in anaerobic incubation increases odor intensity and offensiveness (Figure 15 and 16).
- Odor becomes more intense and offensive with increasing time under anaerobic conditions in inoculated pit water (Figure 17).

Anaerobic decomposition results in odor formation, which is more sever with more microbes and longer time; therefore anaerobic activity should be avoided to reduce odor formation.

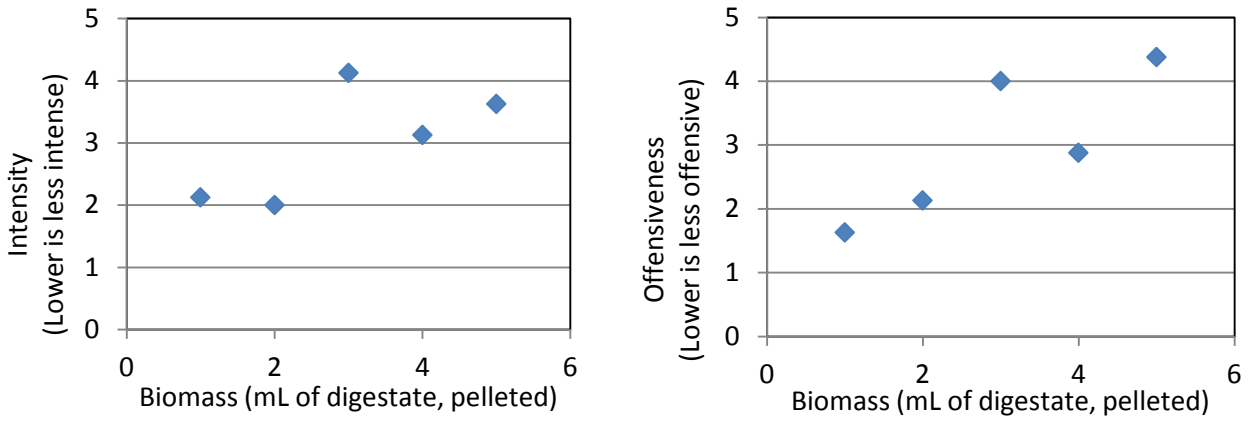

Figure 15. Effect of anaerobic (no headspace) incubation (4 hr) with anaerobic digester inoculum loading on odor using the ranking method. Samples are pea pit water.

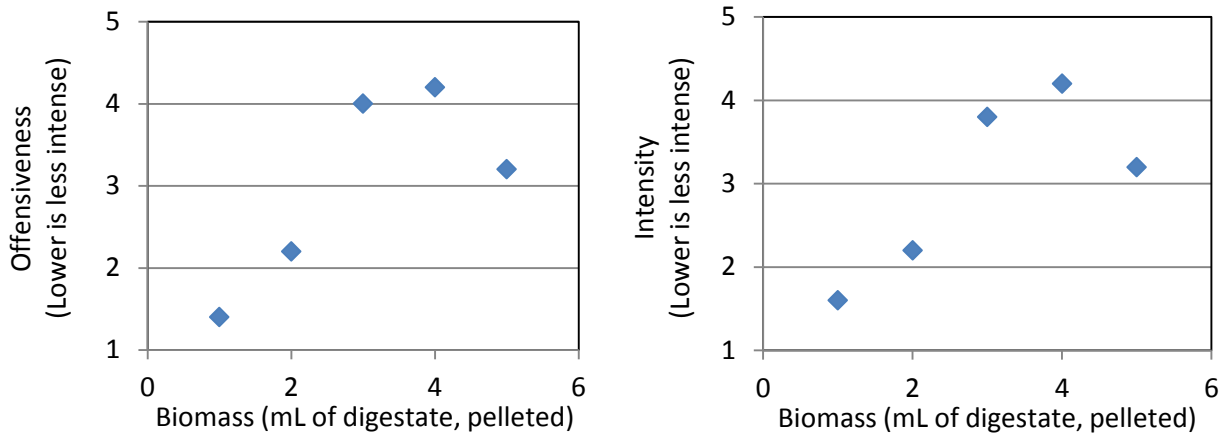

Figure 16. Effect of anaerobic (no headspace) incubation (4 hr) with anaerobic digester inoculum loading on odor using the ranking method. Samples are carrot pit water.

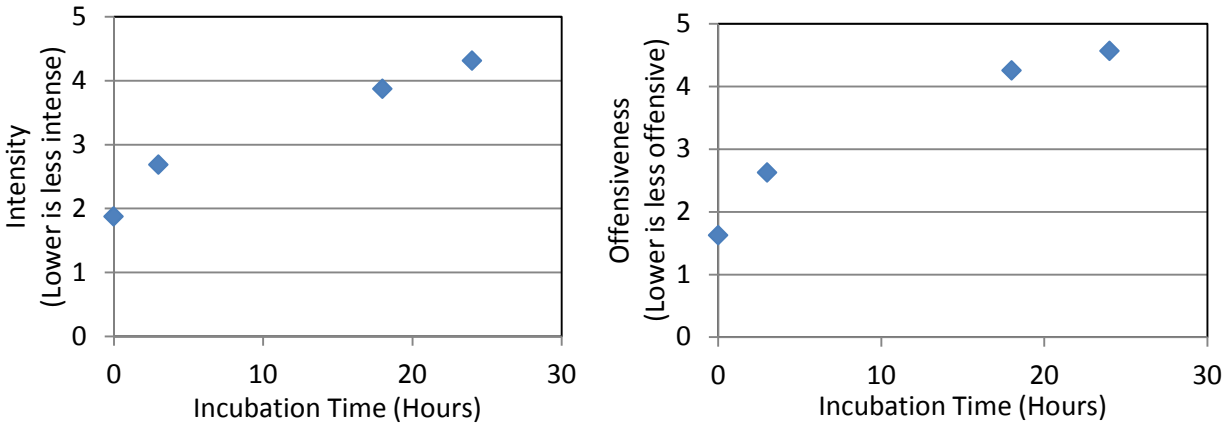

Figure 17. Effect of anaerobic (no headspace) incubation time with anaerobic digestor inoculum on odor using the ranking method. Samples are carrot pit water.

Numerical Rating Method

We have observed that anaerobic incubation increases odor intensity and offensiveness with pit water. As the ranking method does not provide information on the degree of odor change, we performed one odor panel where the panelists gave each of the samples a rating (degree) of intensity and offensiveness between 1 and 10 (a 1 for very offensive and a 10 for not offensive). This allowed for samples to be categorized as equivalent or extreme. The samples were carrot pit water incubated aerobically (headspace, closed cap) or anaerobically (no headspace and closed cap) with varying amounts of digester inoculum. The panelists clearly rated the odor of water that had been anaerobically incubated in the presence of inoculum as significantly more intense and offensive than no treatment or aerobic incubation (Figure 18).

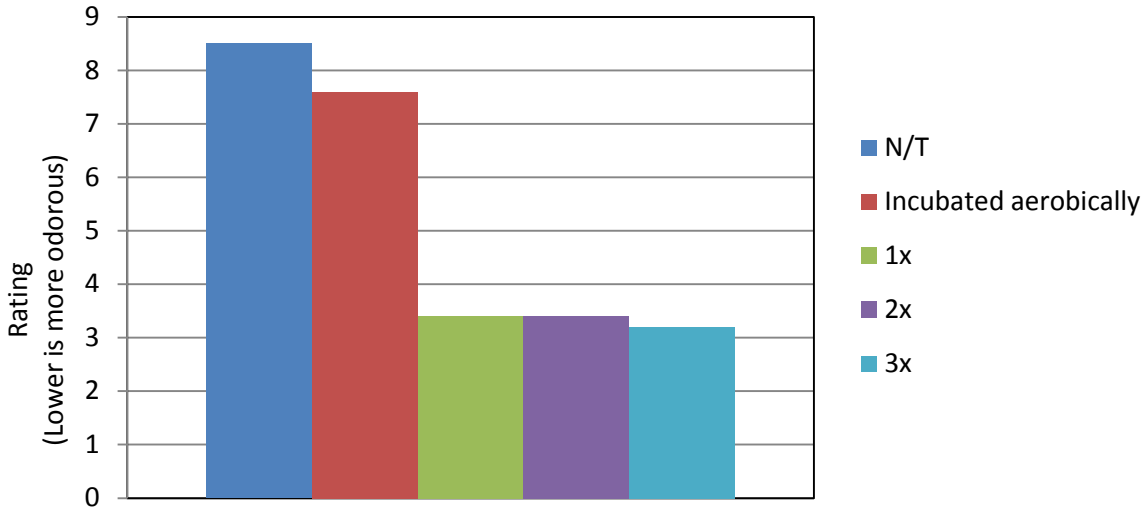

Figure 18. Effect of aeration (aerobic) verses anaerobic incubation on odor assessed by the rating method. The sample is carrot pit water. 1x, 2x, and 3x refer to increasing inoculum loading in the anaerobic treatments.

Best Practices Survey

In a survey (see the following 2 pages) of 43 Pacific Northwest companies (not including Hermiston Foods) that use process water for irrigation performed by Oregon State University, no company indicated that odor has become such a concern that existing practices were altered. Although 13 of the companies surveyed used taper bore nozzles, the least odorous nozzle, none of them did so due to odor concerns. Three companies surveyed used ponds or basins to store waste water before reapplication to fields. None of these ponds were covered or treated due to odor. One company that processed onions acknowledged odors, but stated that they did not engage in practices specifically for odor control.

Seven companies used drip irrigation or irrigation canals to supply water to their fields. The companies did not indicate any odor control issues.

No company surveyed indicated that it routinely made decisions based on odor control. *Decision topics based on odor control* listed in the survey were: wind speed, wind direction, temperature, pre-application soil pH, aerobic vs. anaerobic soil activity, pre-application chemical conditions of soil, time of day, season, humidity, and location (with regards to neighboring homes or businesses).

No company sampled indicated the use of air processing methods for odor control, or that it covered standing water in lagoons or storage basins, or provided any information on other methods used for the control of nuisance odors.

Although previously discussed methods for odor control may be effective industry practices, they do not represent actual practices within the agricultural industry in the Northwest given that no single practice was chosen by any of the sampled companies *due* to odor control issues. This is in direct contrast to extensive practices at the Hermiston Foods facility, where a host of operating practices and design strategies are enacted with the explicit intent of reducing odor generations and exposure to neighboring lands.

Industry Best Practices with Regards to Odor Management Survey

All responses to the following questionnaire will be used in a Best Practice Industry Report for odor management of agriculturally applied wastewater. The identity of participating companies and corporations will NOT be recorded or revealed. Only the general industry category will be associated with responses, i.e. "Food packing", "Farming", "Waste Processing", etc.

The Best Practices Report will be shared with participating organizations as well as the Oregon Department of Agriculture and the Department of Environmental Quality. Oregon State University is developing this report for a company that uses food processing waster for agricultural irrigation.

Please mark all methods of odor control used:

Air Processing

- ☐ Packed tower wet scrubbers
- ☐ Fine mist wet scrubbers
- ☐ Activated carbon odor adsorbers
- ☐ Bio-filters
- ☐ Thermal oxidizers
- ☐ Diffusion into activated sludge basins
- ☐ Odor masking agents

Waste Water Processing and Redistribution Methods

- ☐ "Big gun" sprinkler with large bore opening
  - ☐ Stationary
  - ☐ Traveling
  - ☐ Center pivot/linear movement
- ☐ Impact sprinkler with small bore opening
  - ☐ Stationary
  - ☐ Center pivot/linear movement
- ☐ Drop nozzle
  - ☐ Center pivot/linear movement
  - ☐ Boom sprayer
- ☐ Low drift drop nozzle
  - ☐ Center pivot/linear movement
  - ☐ Hosedrag sprayer
- ☐ Large diameter, low pressure, discharge hose
- ☐ Boom sprayer
- ☐ Hosedrag sprayer
- ☐ Tanker wagon
- ☐ Drip emitter at or below ground surface

Methods of Sprinkler Movement

- ☐ Center pivot
- ☐ Linear movement

Dust/Odor Reduction

- ☐ Windbreak walls
- ☐ Shelter belts
- ☐ Washing walls (odor control via evaporative cooling)
- ☐ Oil sprinkling in animal pens
- ☐ Diet manipulation via introduction of synthetic amino acids and crude protein to feed
- ☐ Dry activated carbon sources in animal bedding
- ☐ Manure additives

Storage Basin or Lagoon Odor Removal Methods

- ☐ No cover
- ☐ Impermeable cover
- ☐ Geotextile cover
- ☐ Granular foam cover
- ☐ Fixed foam and geotextile cover
- ☐ Straw bio-cover
- ☐ Permeable synthetic or organic bio-cover
- ☐ Mechanical screens
- ☐ Centrifuges
- ☐ Sedimentation via gravity
- ☐ Ultrafiltration

Considerations Taken into account Because of Odor control/Nuisance

- ☐ Wind speed
- ☐ Wind direction
- ☐ Temperature
- ☐ Pre-application pH
- ☐ Aerobic vs. anaerobic activity in soil
- ☐ Pre-application chemical conditions of soil
- ☐ Time of day
- ☐ Season
- ☐ Humidity
- ☐ Location (with regards to neighboring homes or businesses)

Please describe any methods for odor management of agricultural products not previously described.

_____
_____
_____
_____
_____
_____
_____

Analysis and Conclusions

On occasion odors are apparent in the agricultural fields irrigated by process waters from Hermiston Foods. At times the odors originate from the Hermiston Foods water. This research has not investigated the severity or frequency of odors at the facility, which are intermittent, but instead examined the experimental generation and removal of odors from process water samples.

In the processing facility, the vegetable matter is in contact with hot water. This water can solubilize compounds from the solid vegetable phase into the aqueous (water) phase. These compounds are organic, and may or may not have odor. We do know that experimentally odor develops from storage of water, even at cold temperatures.

There are microbes present in all non-sterilized water and surfaces (like the inside of pipes), and these microbes can metabolize the dissolved organic compounds. Aerobic (with oxygen) metabolism converts the carbon compounds to carbon dioxide without significant accumulation of odor. Anaerobic (without oxygen) metabolism is known to include the generation of organic acids, which are associated with offensive odors. Experimentally we observed offensive odor development in pit water incubated with inoculum under anaerobic conditions. We hypothesize that on the occasions that odor does develop in the agriculturally applied process water, it is due to anaerobic metabolism that occurs in the 3-mile long underground pipe from the pit to the vault. Our experimental results support this hypothesis as follows:

- In some samples a significantly lower pH is measured at the vault than at the pit. In June 2012 this was observed (pit 6.6 pH, vault 4.6 pH) when there was a strong offensive odor at the vault. This is evidence for the formation of organic acids by anaerobic metabolism.
- Oxygen consumption rates (albeit with excess biomass) indicate that dissolved oxygen can be completely consumed in minutes, compared to the multiple hour residence time in the pipe.
- pH adjustment to neutral reduced odor in the ranking odor panels. This supports the hypothesis that odor causing acids were present in vault water (Figure 13).
- Intense and offensive odor was consistently formed from pit water by incubation under anaerobic conditions (Figure 15, 16, 17, and 18).

Potential solutions to odors include treating the odors after they develop or inhibiting generation of odors. Hermiston Foods uses strategies to mitigate the generations and spread of odors (e.g. removal of solids via high quality screens). Our experimental investigation of vault waters (after storage and odor development) indicates that treatments can reduce odor; however, the change is small and the expense would be large. Stripping removes odors from the water, but would only increase exposure to neighbors by transferring the odor to the atmosphere. Inhibiting the generation of odors is the lowest risk approach.

An example of a potential method to reduce the formation of odors is adding oxygen to the water prior to transport in the 3-mile long pipe to inhibit anaerobic metabolism and odor formation. Much less oxygen than is required for the maximum oxygen degradation rate will inhibit

anaerobic metabolism. In a hypothetical example, we assume 20% of the maximum consumption rate will inhibit the formation of anaerobic odor compounds. This value is an assumption, and the actual value would be lower if every microbial cell was exposed to sufficient oxygen to provide an aerobic environment. However, this is difficult to measure without experimentation in the full-scale system. The mass flow rate of oxygen required to supply the maximum consumption rate is about 1.9 kg/min (Equation 2).

$$\dot{m}_{oxygen} = 4.1 \frac{mg\ oxygen}{L\ min} \cdot 122385\ gal \cdot \frac{3.78L}{gal} \cdot \frac{g}{1000\ mg} \cdot \frac{kg}{1000g} = 1.9 \frac{kg}{min} \quad \text{(Eq 2)}$$

This oxygen could be supplied via air sparging into the pipe from the pit to the vault; however this could lead to cavitation, corrosion, and buildup of gas in high zones of the pipe, and is not recommended. Some waste water processes add hydrogen peroxide (H_2O_2 liquid) to mixtures that are piped long distances to inhibit the formation of anaerobically generated odors. Using the 20% of maximum assumption, the amount of H_2O_2 added to the water at the pipe is about 16 L/hr (Equation 3), which would be completely consumed within the pipe, prior to reaching the vault.

$$\dot{m}_{H_2O_2} = 0.20 \cdot 1.9 \frac{kg}{min} \cdot \frac{mL}{1.45g\ H_2O_2} \cdot \frac{1000\ g}{kg} \cdot \frac{L}{1000\ mL} = 0.26 \frac{L}{min} \approx 16 \frac{L}{hr} \quad \text{(Eq 3)}$$

Adding H_2O_2 incurs capital costs for a delivery system (metering pump, H_2O_2 storage, etc.) and operating costs (labor and maintenance for the delivery system, H_2O_2). Amortized over time, a dominant cost is the H_2O_2, which is about $400/ton. At a flow rate of 16 L/hr, the H_2O_2 cost is about $10/hr.

$$Cost_{H_2O_2} = \frac{\$400}{ton} \cdot \frac{ton}{1000\ kg} \cdot \frac{1.45g\ H_2O_2}{mL} \cdot \frac{kg}{1000\ g} \cdot \frac{16\ L}{hr} \cdot \frac{1000\ mL}{L} \approx 10 \frac{\$}{hr} \quad \text{(Eq 4)}$$

This example of H_2O_2 addition is one of several potential solutions that could be proposed to reduce the formation of odor.

Complicating interpretation of the odor assessments in this study is the dynamic nature of the water reuse operating process (changing flow rates and organic loadings) and the snapshot nature of the grab samples assessed. Proposing strategies for odor management is further complicated by the intermittent generation of odor that has been observed. Currently Hermiston Foods has adopted practices to manage odor control at the facility including aeration of the lagoon, dilution of the process water in the vault, immediate delivery of the water to fields (reducing residence time in the system), coordinating irrigation with wind speed, planting tree barriers, low irrigation nozzles with larger droplet sizes, drag tubes on the ends of pivots, high efficiency screening and flushing irrigation piping with fresh water prior to down time. This list is not exhaustive as the facility adopts new practices upon evaluation of the effectiveness of their odor management practices. In this study we have evaluated conditions that reduce odor from vault water (which may or may not have significant odor) and been able to consistently generate odor in pit water through anaerobic incubation.

Appendix A. Personnel Involved with the Hermiston Project (Best Practices and Laboratory Studies)

Personnel in chronological order of involvement:

Christine Kelly (CBEE Faculty): Project leader, logistics, administration, Hermiston Foods water sampling, Best Practices report editing, Laboratory Studies report (Summer 2011-Summer 2013)

Mark Dolan (CBEE faculty): Project initiation (Summer - Fall 2011)

Josh Marsh (ChE undergraduate student): odor panels, COD measurements (Fall 2011-Winter 2013)

Jimmy Beaty (ChE undergraduate student): odor panels, COD measurements, respirometry (Fall 2011-Winter 2013)

Stephani Silliman (ChE graduate student): first draft of best practices report, discussions with national extension agents (Fall 2011)

Evelyn Harper (EnvE undergraduate student): first draft of best practices, discussions with national extension agents, BOD and COD measurements (Fall 2011)

Chelsea Stewardson (ChE undergraduate student): odor panels (Fall 2011)

Geoffrey Zath (ChE undergraduate student): odor panels (Fall 2011)

Pat Dysart (Crop and Soil Science Research Associate): Best Practices Document (Winter 2011-Summer 2012)

Karl Schilke (CHE faculty): IRB (Spring 2012)

Nolan Kelly (HS Student): Best Practices report editing, Company survey (Summer -Fall 2012)

Appendix B. Respirometry Data

Respirometry - Hermiston Foods Vault Water Sample													
1X Innoculum	Time (s)												
Trial % O_2	0	15	30	45	60	75	90	105	120	135	150	165	180
1	103.3	93.2	84.1	77.6	73.4	70.2	67.6	65.1	63	61.2	59.6	58.1	56.8
2	101.1	96.4	85.1	78.1	72.2	67.5	63.8	60.4	57.6	55	52.8	50.6	48.7
3	107.2	93.1	78.1	67.3	61.3	56.2	53.2	49.8	46.9	44.8	43	41.1	39.5
Avg	104	94.2	82.4	74.3	69.0	64.6	61.5	58.4	55.8	53.7	51.8	49.9	48.3
% Max DO	100	91	79	72	66	62	59	56	54	52	50	48	47
		slope	-0.68785	-0.64442	-0.57574								
	mg oxygen/L min		-3.71	-3.48	-3.11								
2X Innoculum	Time (s)												
Trial % O_2	0	15	30	45	60	75	90	105	120	135	150	165	180
1	123.3	111.1	100.1	92.2	86.3	81.5	77.5	74	70.8	67.9	65.5	63.2	60.8
2	116.4	104.2	89.6	77.1	68.5	61.6	55.4	50.4	46.2	42.3	39.1	36.1	33.3
3	114.5	101.7	83.3	70.4	61.6	54.3	48.7	43.6	39.5	35.6	32.6	29.4	26.9
Avg	118	106	91.0	79.9	72.1	65.8	60.5	56.0	52.2	48.6	45.7	42.9	40.3
% Max DO	100	89	77	68	61	56	51	47	44	41	39	36	34
		slope	-0.76416	-0.72934	-0.66422								
	mg oxygen/L min		-4.13	-3.94	-3.59								
3X Innoculum	Time (s)												
Trial % O_2	0	15	30	45	60	75	90	105	120	135	150	165	180
1	100.6	98.6	92.6	86.3	82.7	78.1	75.1	71.8	69.3	66.4	64.3	62	59.9
2	115	101.1	93.6	87.5	83.2	79.1	76.1	73	70.6	68.2	66.1	63.8	61.8
3	116	103.1	92.2	85.3	79	73.8	69.5	65.8	62.5	59.2	56.3	53.5	51
Avg	111	101	92.8	86.4	81.6	77.0	73.6	70.2	67.5	64.6	62.2	59.8	57.6
% Max DO	100	91	84	78	74	70	67	64	61	58	56	54	52
		slope	-0.53478	-0.48633	-0.43647								
	mg oxygen/L min		-2.89	-2.63	-2.36								

Appendix C. IRB Research Protocol for Odor Panels using Human Subjects

RESEARCH PROTOCOL

- Protocol Title: Hermiston Foods Odor Management

PERSONNEL

- Principal Investigator: Dr. Christine Kelly
- Student Researcher(s): Elizabeth Humphrey, Joshua Marsh, Jimmy Beaty
- Co-investigator(s): Dr. Mark Dolan, Dr. Karl F. Schilke
- Study Staff: N/A
- Investigator Qualifications:
  Dr. Kelly is a senior research professor in Biological Engineering. Her work in biological process design and scaleup, and transformation of lignocellulosic plant matter into fermentable feedstocks for biofuels offers a broad knowledge base for systematically investigating the cause of odors due to bacterial fermentation. **Dr. Dolan** is a research professor in Environmental Engineering, specializing in modeling and study of microbial transformations and the fate of organic contaminants and other compounds in natural and engineered waterways. **Dr. Schilke** is a faculty research assistant with a diverse background in chemical and biological engineering, food science, organic chemistry, and biochemistry.

- Student Training and Oversight:
  Student workers (listed above) will be involved in all phases of the development and execution of the proposed study, with close supervision by Drs. Kelly and Schilke. Students will contribute to the research development and reporting, but will not complete or submit any required paperwork (e.g. IRB documentation). Prior to the study, all student and faculty personnel will demonstrate CITI certification for ethical use of human subjects in research. Students will not interact directly with any human subjects, but will participate in the collection and analysis of data. All analysis and reporting will be done in collaboration with one of the PI/Co-I's, and students will be reminded of the ethical and legal requirements to avoid disclosure of study participation or personally-identifiable information at the beginning and end of each analysis session. No interruptions from e.g. sabbaticals or changes of student or faculty personnel are expected during the data collection/analysis part of the study.

FUNDING

- Sources of Support for this project (unfunded, pending, or awarded):

  This study is unfunded.

  - Any external source(s) of material: **Samples of vegetable wash- and waste-water will be collected with permission from the Hermiston Foods processing plant**.

DESCRIPTION OF RESEARCH

- Description of Research:

The project consists of analysis of waste- and washwater from Hermiston Foods after storage under various conditions. The water samples will be analyzed for BOD, COD, turbidity and chemical composition. In addition, sensory analysis of the water (to establish detection limit and degree of objectionable odor from different treatments) will be assessed. This important sensory component of the study is the motivation for requesting IRB approval.

- Background Justification:

  Proper treatment of waste and wash waters in the vegetable processing industry is of great importance to minimize the production of objectionable odors. This is particularly important when potentially odorous waters are reused to irrigate crops by spraying onto fields near housing areas. The proposed research seeks to determine the primary factors that influence the production of malodorous compounds in these waste waters. Such information has not been widely reported in the literature, and is known to vary substantially with the type of foods being processed and effects of the local environment. Also, people vary greatly in both their detection limits and perception of "objectionable" odors, so it is very important to complement traditional chemical analysis methods with thorough sensory characterization of the waste water. For instance, some organics are perceived as pleasant at low concentrations, but become extremely offensive at higher concentrations. Improved understanding of the effects of water handling and storage conditions on odor production will enable the development of state-wide Best Practices Guidelines for reuse of waste water in irrigation. These guidelines will help local food processors better manage their use of waste water irrigation, in order to maximize the efficiency of water use, while avoiding costs and negative publicity arising from conflicts with neighboring communities over odor issues.

- Multi-center Study:

  OSU is the only institution involved in this study.

- External Research or Recruitment Site(s):

  No external recruitment sites will be used.

- Subject Population:

  A cohort of approximately 150 sensory panelists will be enrolled for this study. A large number of participants is necessary for statistical validity. Participants will be required to be over the age of 18 years old. Recruitment will be primarily from undergraduate and graduate students and faculty in Chemical, Biological and Environmental Engineering (CBEE). However, the study does not specifically exclude other OSU faculty, local citizens, or other qualified individuals from outside the Corvallis area.

  The researchers will explicitly exclude participants from the following populations:
  - Minors, prisoners and developmentally challenged persons (informed consent issues)
  - Pregnant women (because pregnancy often causes strong and irreproducible changes in the sensitivity to odors and their perception as "pleasant" or "offensive")
  - Non-English speakers (odor sensory evaluation is a language-intensive process, and interpreters are not easily available)

  Sensory panelists will be recruited from among the students enrolled in Dr. Dolan's ENVE 321 course (Env. Engr. Fundamentals; 107 students), and Dr. Kelly's BIOE 459 (Cell Engr.; 43 students) and BIOE 490 (Bioengr. Process Design; 21 students). The remainder of the panelists required to reach 150 participants will be recruited in an ad-hoc manner from among the CBEE grad students & faculty. The recruitment process is described below.
  Recruitment of participants from the above-named courses offers an opportunity for students in Environmental and Biological Engineering to participate in a study applying biological and engineering principles to solve real-world principles. A case study of the project and its underlying fundamental processes will be discussed in lectures for each of the courses. This also enables recruitment from a large pool of interested potential participants, without the need for monetary compensation (there is no formal funding source for this study).
  Student recruits will be asked to participate in sensory evaluation panels to be held outside of scheduled class times. Student participants will be compensated with a small amount of extra credit.
  Any students who are excluded from or not interested in participating in the study will be given an equivalent amount of extra credit for a short (1 paragraph) written assignment. They will be asked to write a description of the problem being addressed in the study, and to apply concepts learned in the course to suggest at least one possible engineering method to remedy the problem. Students will be given extra credit for enrolling in the study, regardless of whether or not they actually participate in the study. Faculty and ad-hoc panelists will not receive any monetary or other compensation for participation in the study.
  Recruitment will be through an in-class advertisement presented twice at the beginning of consecutive lectures. The advertising slide (see attached) includes the following information:

  - Title of the study
  - PI's name and contact information
  - Research statement and objectives
  - Eligibility requirements
  - Compensation and alternatives (extra-credit)
  - Contact information for enrollment information

Students will not be asked in any public venue to indicate their interest in or intent to enroll in the study. A printed version of the materials, identical except that no compensation will be offered, will also be distributed to CBEE graduate students and faculty to inform them of the opportunity to participate in this study.
The PI will answer any written or verbal questions about the purpose, benefits or risks of participation in the study. The PI will also respond to enrollment requests by scheduling testing sessions in a timely fashion for each interested participant. Panelists will be asked to sign a written consent form (see attached) at the time of their participation in the study.
After the study is completed, the results and possible engineering solutions for the project will be discussed as a case study in each of the aforementioned courses.

- Consent Process:

  A written informed consent form (see attached) will be distributed to each panelist prior to each sensory testing session. The panelists will be required to read and sign the consent form, indicating their understanding of the requirements, risks, benefits and compensation, before they begin participating in the study.
  Written consent forms will be collected and stored under lock-and-key by the PI, and will not be disclosed to any party outside those named as study personnel (above) to the extent permitted by law. Consent forms will be destroyed three years after publication of the results of the study, and do not contain any identifiers that could be used to link specific study responses or comments to an individual panelist. Student workers will be trained in ethical use of human subjects, and will be supervised by the PI/co-I during all phases of the study.

- Assent Process:

  No minors or cognitively impaired persons will be included as participants in this study.

- Eligibility Screening:

  Prospective panelists will not be screened prior to requesting their consent to participate in the study, except as individuals self-exclude themselves based on the written research goals and eligibility requirements. The consent form includes a statement of the eligibility requirements for the study, and any prospective panelist who cannot meet these requirements is expected to voluntarily decline to participate. No pre-screening data will be solicited or stored during the study.

- Methods and Procedures:

  Collection of Vegetable Washwater Samples
  Samples of vegetable wash waters for chemical and sensory analysis will be collected from a variety of locations throughout the Hermiston Foods process stream. In particular, wash-water samples will be taken at the point of generation, and from storage and holding tanks, connecting pipelines, an artificial outdoor lagoon, and at the points of application of the recycled water to crop fields. Control samples of clean water will be taken from inside the plant, and from nearby businesses. These samples will be kept on ice or refrigerated at all times, except during preparation and evaluation of samples for sensory analysis. Samples will also be subjected to chemical analysis (pH, dissolved O_2, BOD, turbidity, analytical chromatography, etc.). Chemical composition and characteristics are expected to correlate strongly with odor, but chemical analysis *per se* is outside of the scope of this IRB proposal. Water samples will be collected during processing of several vegetables (carrots, asparagus, lima beans, and peas) to identify any trends in odor based on type of vegetable.

  Preparation of Materials for Sensory Evaluation
  Aliquots (10 mL) of washwater will be transferred to clean 250 mL, capped bottles, and subjected to a variety of storage and handling conditions. In particular, water samples treatments will be:
  - Held at 4 °C, tightly capped, to serve as a control
  - Shaken at 37 °C (1 hr), with and without oxygen, to encourage microbial growth and transformation of dissolved compounds
  - Adjusted to pH 4 or 9 with NaOH/HCl, to test for changes in volatility of organic compounds
  - "Stripped" of volatiles by bubbling of air through the sample for 1 or 3 hrs
  - Filtered to remove insoluble sediment and organic debris, then held at 37 °C (1 hr)

  After treatment, the bottles containing the water samples will be wrapped with an opaque sleeve, to prevent panelists from being influenced by water color or turbidity. The samples will be labeled with randomly-assigned 3-digit codes to eliminate bias, and immediately distributed to the sensory panel for evaluation. The code numbers will be changed at the beginning of each series of sensory tests (e.g. when the type of vegetable washed in the water is changed, or water collected at a different location is to be evaluated).

  Sensory Evaluation Procedure
  Sensory evaluations will be held with groups of 8-10 panelists. The subjects will be seated at

tables in a clean, brightly-lit room during the evaluation. Each subject will be asked to read, sign and return an informed consent form (see attached) before beginning to participate in the sensory evaluation.

Freshly prepared samples in blinded, numbered bottles with tight-fitting caps will be distributed to each panelist. Panelists will each be provided with a sharpened pencil and a written evaluation form (see attached) that contains concise instructions and spaces for their responses. The panelists will be asked to briefly shake each bottle to evenly distribute the contents, then remove the cap and smell the odors (if any) that emanate from the bottle. The panelists will first be asked to provide demographic information (biological sex and age range). They will then be asked to smell and rank the samples in order of increasing odor strength or intensity, and record the intensity rankings on their form. Finally, they will be asked to rank the samples by offensiveness of the odors. The panelists will be told not to touch, taste, or otherwise contact the water samples during the analysis. No individually identifiable information about the subjects will be asked for or recorded.

Panelists will be encouraged to revisit samples as many times as necessary to decide on the best ranking for each variable. A covered cup containing a small amount of ground coffee will be provided to each panelist, to be used to "cleanse" the nose and minimize olfactory carryover between samples. The evaluation is expected to take no more than 10 minutes.

Note: To accommodate the large number of sensory panelists, sample preparation will be staggered and carried out continuously, so that freshly-treated samples will always be available for sensory analysis immediately after completion of the various treatments.

<u>After Completion of Sensory Analysis</u>

Panelists will be allowed to leave the testing room upon completion of their rankings (or at any point during the test, if they wish). No followup contact will be initiated by the PI, but subjects will be encouraged to contact the PI if they have any questions or comments after the study. Summaries of the results of the completed study will be provided to any panelist who submits a written request for the results. Water samples will be flushed down the sanitary sewer with copious water and the bottles washed in a commercial dishwasher after the evaluation is complete.

<u>Data Aggregation, Analysis and Reporting</u>

Anonymous demographic and ranking data will be transcribed from the panelist response forms to a spreadsheet. The written forms will then be destroyed. Statistically significant differences between samples, age groups, and sex will be determined by ANOVA using the StatGraphics Centurion XVI™ statistics package (StatPoint Technologies, Warrenton, VA). Aggregate statistics for each type of vegetable and sampling location will be collected, and the results used to validate qualitative models for sources of washwater odors and the effects of handling or storage on the intensity and offensiveness of odors. These models will be based on chemical/biological engineering principles such as microbial fermentation and chemical oxidation of food-derived substrates to produce odor compounds during storage and transport of the wash water. The offensiveness data will be used to help identify classes of compounds that are responsible for malodorous waters, and this information will inform the definition of "best practice" guidelines for wash-/waste-water handling prior to reuse for irrigation or other agricultural processes. Aggregated results will also be provided to our industry partners (Hermiston Foods) to help them determine where process improvements might be made.

- Compensation:
  As described above, all students recruited in the study through ENVE/BIOE courses will be compensated with extra-credit points for enrolling in the study. No penalty will be given for failure to participate in the study (extra credit will be given at the time of enrollment). An alternative, optional written assignment will be provided for those unable/unwilling to participate in the study. The same number of extra credit points will be provided to any student who either enrolls in the study or turns in the optional written assignment. The written work will not be graded based on content or effort. Completion of the optional written assignment will not be required or compensated for those enrolled in the study.

- Cost: **No specific travel/parking/etc. costs are expected.**

- Drugs or Biologics **No drugs or biologics will be used in this study.**

- Dietary Supplements **No dietary supplements will be used in this study.**

- Medical Devices **No medical devices will be used in this study.**

- Radiation **No radiation will be used in this study.**

- Biological Samples **No biological samples will be used in this study.**

- Anonymity or Confidentiality:

  Sensory panel participants will *not be asked to provide any individually-identifiable information (including their name, date of birth, race, etc.)* for purposes of this study. Panelists will be asked to divulge their age range (e.g. 30-35 years old), and their sex. These data will serve as controls for sex differences and age-related changes in the sense of smell between participants. All data will be aggregated and divulged as statistical summaries in published reports. Any specific individual responses used in publications (e.g. a written comment about the offensiveness of a sample) will be carefully sanitized to remove any information that could be used to identify an individual panelist or group of panelists. Only the aggregated data summaries and sanitized written comments will be archived for this study – all individual responses will be kept confidential and destroyed immediately after data analysis and aggregation.

  The panel's signed consent forms will be retained for three years following the termination of the study. *The panel's sensory evaluation responses will not be linked in any manner to their consent forms*. No identifiers that could connect a panelist's responses with their consent form will be used in this study. Although disclosure of participation in the sensory panel is not expected to carry any undue risk to the panelists, the signed consent forms will be kept under lock and key in the PI's control. All consent forms will be destroyed after completion of the three year post-study retention period. Students in the PI/co-I's courses will receive extra credit points for enrolling in the study – these points will be hidden from other students' view in BlackBoard™ and other grade lists, to maintain confidentiality of their participation in the study.

At their written request, panelists will be provided with a written summary of the findings of the study. No information that could be used to identify the other panelists, the researchers, or any participating commercial or academic partners will be included in these summaries.

- Risks

The risks to participants in this study are very slight, as they will be asked only to smell commercial vegetable wash-/wastewater samples and evaluate the intensity and offensiveness of odors detected in them. Such odors arise solely from extraction of odor components from edible food sources, and any products of natural chemical oxidation or fermentation processes on these compounds. Similar odors often arise in domestic kitchens, bathrooms, ponds, etc. and are no more hazardous in this study than these common sources. *Participants will not be asked to ingest, taste, touch, or otherwise contact the samples in any way*.

The primary risk associated with evaluation of wash-/wastewater odors is the possibility of exposure to malodorous or irritant compounds. However, because they are usually produced by living microorganisms, natural fermentation odor compounds are generally innocuous, and have very low toxicity to humans. Exposure to the samples will be very brief, with sensory recovery time built into the study protocol. In addition, the participant will be in complete control of the smelling process at all times, and can thus self-limit or avoid exposure to any samples that they may find irritating or offensive.

Although not impossible, the risk of serious allergic reaction is very remote, as participants will be in contact only with volatile organic compounds. In order to be volatile, a molecule must be very small; dangerous systematic immune/allergy responses are usually induced only by much larger molecules, such as the foreign proteins in e.g. peanuts or bee venom. In the unlikely event of an allergic reaction or other medical emergency, the OSU or Corvallis emergency response personnel will be immediately summoned to provide medical care as needed. Should accidental contact with wash water samples occur, the affected areas will be rinsed with copious water and, as a precaution, disinfected with 70% rubbing alcohol. The subject will be asked to self-monitor the affected area and seek medical attention if any adverse reaction (e.g. a rash) occurs. In either case, the proper IRB "Unexpected or Adverse Event" and OSU Accident Reporting paperwork will be filed immediately by the PI or co-I's.

- Benefits:

There are no specific direct benefits to participants in this study. The major potential benefit to society and industry include an improved understanding of how wash- or waste-water handling and storage impacts the release of objectionable odors, when water is reused for irrigation or other agricultural purposes. In addition, methods for sensory analysis of wash water will be developed to support future studies of such issues.

A set of "Best Practice Guidelines" for wash-/wastewater reuse, to be provided to the Oregon DEQ and Dept. of Agriculture, is an important expected outcome of this study. These guidelines will help local food processors maximize their water efficiency, and avoid

conflicts with neighboring communities over reuse of malodorous waters.

- Assessment of Risk:Benefit ratio:

  The risks associated with the study are very minimal and, at worst, very short-lived. Sensory analysis of wash and wastewater will enable the publication of a set of guidelines that will potentially lead to large and long-lasting benefits to various agricultural and food processing industries in the Pacific Northwest. In particular, this study will enable improvements in water reuse and recycling, and help to reduce conflict with neighboring communities. These benefits are not limited only to the industrial processors, but will also benefit the surrounding communities by minimizing offensive odors, and help to conserve precious water resources.

Hermiston Foods
Activity Status Update – as of Nov. 20, 2013

Site Inspections

Feb. 9, 2011	Technical Assistance Inspection
June 21, 2011	Public Hearing on Permit Modification
July 12, 2011	DEQ Site visit with OSU
July 22, 2011	NORPAC and DEQ executives meet with OSU
Aug. 8, 2011	Permit Modification
Sept. 30, 2011	Compliance Inspection- In Compliance
Oct. 4, 2011	Compliance Inspection- In Compliance
Nov. 22, 2011	DEQ meets with ODA to discuss health issues
May 30, 2012	Compliance Inspection- In Compliance
June 22, 2012	Compliance Inspection- In Compliance
July 26, 2012	Compliance Inspection- In Compliance
July 26, 2012	Compliance Inspection- In Compliance
May 25, 2013	Compliance Inspection- In Compliance
June 12, 2013	Compliance Inspection- In Compliance
June 28, 2013	Compliance Inspection- In Compliance
July 10, 2013	DEQ Pendleton received copy of OSU Final Report
July 25, 2013	Compliance Inspection- In Compliance
Sept. 26, 2013	Compliance Inspection- In Compliance
Oct. 26, 2013	Compliance Inspection- In Compliance

DEQ received 28 complaints in 2013 related to odor from Hermiston Foods

During the 2012 and 2013 irrigation seasons there were no documented incidents of over-spray or wind-drift.